A TRANSCENDENTAL PHENOMENOLOGICAL STUDY EXAMINING SCIENCE FACULTY EXPERIENCES WITH CHANGE WHEN TRANSITIONING FROM TRADITIONAL LABORATORIES TO NON-TRADITIONAL LABORATORIES

by

Jessie Bostic

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

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Abstract

The purpose of this transcendental phenomenological study was to describe science faculty's experiences with change as they transitioned from using traditional laboratories to using non-traditional laboratories at postsecondary institutions. The theory that guided this study was the transtheoretical model of change, as it explains the processes of change the faculty may have gone through as they transitioned from using traditional laboratories to non-traditional laboratories. A transcendental phenomenological qualitative design was used with a sample of 10 purposely selected post-secondary science faculty members to answer the study's central question: What are the shared lived experiences of science faculty transitioning from traditional laboratories to non-traditional laboratories at post-secondary institutions? Data collection included semi-structured interviews with each participant, a sample of a non-traditional laboratory exercise chosen by the participant, and a semi-structured focus group discussion forum. Moustakas's transcendental phenomenological data analysis triangulated the pertinent themes found through reduction, horizonalization, and imaginative variation. There were four themes identified in the study: support during the transition, the effects of infrastructure on the transition, the faculty's change in role during the transition, and the faculty's embracement of change.

Keywords: online learning, nontraditional laboratories, science education, higher education, science faculty, remote labs, online labs, lab kits

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Non-Traditional Laboratory (NTL)

Traditional Laboratory (TL)

Transtheoretical Model of Change (TTM)

CHAPTER ONE: INTRODUCTION

Overview

Online learners are increasing (National Council for State Authorization Reciprocity Agreements [NC-SARA], 2022)), but options for science majors, especially in natural science fields, are limited at four-year institutions (Varty, 2016). The imbalance could be due to the laboratory component often required in these courses (DeBoer et al., 2019; Goacher et al., 2017). However, overwhelming research suggests most students perform the same or better on learning outcomes with virtual laboratories as they do with traditional laboratories (TLs) in a range of subjects, including introductory science courses (Faulconer & Gruss, 2018), many STEM courses (Chirikov et al., 2020; DeBoer et al., 2019), physiology (Durand et al., 2019; Wilson et al., 2018), anatomical sciences (Kao & Leo, 2018; Massey et al., 2021), physical science (Miller et al., 2018), microscope based courses (Herodotau et al., 2020), chemistry experimental courses (Irby et al., 2018); and engineering courses (Nolen & Koretsky, 2018; Reck et al., 2019). But for faculty members, transitioning from TL) to non-traditional laboratories (NTLs), like virtual settings, can be difficult (Barton, 2020). The purpose of this transcendental phenomenological study was to describe science faculty experiences with change as they transition from using TLs to using NTLs at postsecondary institutions. This chapter presents the background, including the historical context of online learning and laboratories in science courses, the social context of shifting laboratories to a virtual platform, and the theoretical context, including relevant research through the literature review. The gap in the literature revealed a lack of sources describing the experience with change while science faculty navigated adapting to teaching NTLs. The problem and purpose statement will anchor the current research and provide a clear significance for the current study, including empirical, practical, and theoretical significance. The central and sub-

research questions address the faculty's experiences with change transitioning from TLs to NTLs. The essential definitions will be provided, and the chapter will close with a summary.

Background

Important background information for the current study includes the history of online education and NTLs, the social context of transitioning TLs to NTLs, and the theoretical context of science education and laboratory components. Online education has evolved from once using postal mail correspondence to the sizeable online platform available today. Transitioning science courses to an online platform eliminates the traditional face-to-face science laboratory's physical experience, and NTLs provide an alternative option. For those who do make the transition to an NLT, several reviews of research suggest no difference in learning outcomes between TLs and NTLs in science courses (Chirikov et al., 2020; Faulconer & Gruss, 2018), but little is known about the changes faculty may face when transitioning lessons from TLs to NTLs.

Historical Context

All NTLs are associated with online courses (Brinson, 2015; Chirikov et al., 2020) and were created to keep up with the evolution of distance education over the years (Allen & Seaman, 2015). Because NTLs and distance education are inextricably linked, an understanding of the development of online education helps provide a foundation for understanding the historical context of NTLs. Distance education has evolved from correspondence education in the late 1800s using a printing press and post office for distribution to today's online formats (Anderson & Simpson, 2012). The history of distance education is often referred to as generational. However, the generations may differ between Nipper's (1989) three-generational framework ending in computer conferencing, Moore and Kearsley's (2005) three-generational model ending in a developing systems approach, and Taylor's (2001) five-generational

framework including digital technologies. The aforementioned authors agree that the first generation of distance learning included a printing press and the postal mail, referred to as correspondence education (Anderson & Simpson, 2012).

The second generation of distance learning includes radio and broadcast lessons from studios into homes (Anderson & Simpson, 2012). The first and second generations taught teacher-centered lessons with little or no teacher and peer interactions. However, the intention of distance education has remained the same, providing those students with limited access to traditional education a path to education. It was not until the third generation of distance education that the concept of conferencing was introduced through asynchronous computer conferencing by Nipper (1989) and synchronous teleconferencing by Taylor (2001). The third generation of distance learning shifted the focus from didactic teaching to a more social constructivist approach (Anderson & Simpson, 2012).

The internet was not available to the average person until about 1995. However, between 1982 and 1995, the Computer Assisted Learning Center (CALC) used networking computers and phone line communication. Then, in 1995, CALC became the first totally online school (Morabito, n.d.). In 2019, before the pandemic had any effect on distance education, 3 million students were enrolled in fully online programs, a 7.5% increase from 2018 (NC-SARA, 2022). In 2020, during the pandemic, this number almost doubled, with 5.8 million students in fully online programs. Although the COVID-19 pandemic was a catalyst for the number of fully online students in 2020, 59% of institutions plan to continue offering some or all their emergency remote learning offerings through distance education after the pandemic is over. In the fall of 2021, the number of fully online students decreased as students returned to campuses as the pandemic slowed; however, the number was still 4.2 million, which is higher than in the last

stable year of 2019. This increase in demand for distance education opportunities will affect all programs, including science.

Many science courses require a laboratory component that allows the students to apply the concepts and topics covered in the lessons to real-life situations (Goacher et al., 2017). Research suggests that science students perform better when the course includes a laboratory element (DeBoer et al., 2019; Goacher et al., 2017). TLs occur inside an educational building where the instructor is present face-to-face with the students. The students experiment with the equipment hands-on; this lab type is often called a hands-on lab (Alkhaldi et al., 2016; Brinson, 2015). TLs may also include field activities where the students interact with nature (Fleischner et al., 2017). In these labs, the instructor is present with the student and equipment. For many years, TLs were the only labs offered (Alkhaldi et al., 2016), limiting science courses with lab components to face-to-face platforms only.

Today, technological advances have made laboratories outside the traditional science lab possible. NTLs can occur online virtually where the student observes an experiment through video, controls equipment virtually through online programs, or carries out an experiment with equipment from a lab kit in their homes (DeBoer et al., 2019; Faulconer & Gruss, 2018). These may also be referred to as non-traditional practical work (Drysdale et al., 2020). There are multiple types of NTLs which are often generalized by literature as online labs; however, there are differences based on the student's control, or lack of, during the exercise. A virtual laboratory is where the student observes a pre-recorded real lab or simulation on a computer (Chirikov et al., 2020). The student does not input any data or control any equipment. A remote lab is where the student controls real or simulated equipment through a computer (Brinson, 2015; Chirikov et al., 2020). The student inputs instructions or commands and collects data from the experiment.

Lastly, at-home labs are where the student carries out hands-on laboratory exercises in the location of their choice, often their homes, using a lab kit provided as part of the course materials. In this setting, the student physically manipulates the equipment and collects first-person data from the results using a provided at-home lab kit.

Natural science majors are not offered at all entirely online institutions. In the fall of 2021, the three institutions that were completely distance education with the largest reported total students were Western Governors University, Southern New Hampshire University, and the University of Phoenix. A quick online inquiry of the three universities proved that environmental science was the only entirely online natural science degree offered at the University of Phoenix and Southern New Hampshire University, with no biology major. No natural science degrees were offered at Western Governors University. There were, however, online options for science courses, such as biology, for non-majors to enroll in to fulfill humanity degree requirements at each school. Overall, online biology course offerings were fewer than other courses at most four-year institutions (Varty, 2016), and biology is a typical undergraduate pre-medical major. With the growing access to personal computers, the internet, and technology and the increasing demand for accessible education (Mitchell et al., 2015), it is apparent that some natural science majors are being left behind in the opportunistic world of online learning. Still, the cause for the difference could not be identified through a literature review.

Although the current study did not focus on transitioning to NTLs from TLs during the COVID-19 pandemic, the effect of the pandemic on online learning cannot be ignored. Education was forced to embrace the platform like never before (Barton, 2020; D'Angelo, 2020). Faculty who had never taught an online class were forced to teach all course elements online, and many were left feeling anxious and vulnerable (Cutri & Mena, 2020). Science faculty found

it difficult to transition into an online classroom because of the need for hands-on labs and fieldwork (Barton, 2020). During the pandemic, faculty were forced to create online and virtual substitutes with a moment's notice, no training, and under pressure (Barton, 2020; D'Angelo, 2020). The limited feedback on the experience was not positive (Barton, 2020). However, after the initial shock passed and things resumed a new normal, 59% of institutions plan to continue offering some or all their emergency remote learning offerings through distance education after the pandemic is over (NC-SARA, 2022).

Social Context

NTLs can be a valuable option when a TL is impossible (Drysdale et al., 2020; Faulconer & Gruss, 2018) as they provide a way for students to accomplish all learning outcomes; however, students' feedback on NTLs is mixed. Previous reviews have found that students taking NTLs perform equally or above students taking TLs (Chirikov et al., 2020; Faulconer & Gruss, 2018). Other researchers found that replacing wet labs with simulated labs caused no adverse effect on the student's performances in chemistry (Irby et al., 2018; Reck et al., 2019). Although students may perform the same in both labs, some research suggests that students still prefer TLs (Attardi et al., 2016; Wilson et al., 2018). This may be due to the lack of excitement that computer-simulated labs provide instead of hands-on experiments (de Jong et al., 2013). However, online labs are not limited by funding or location and can provide a significant positive field view from students after participating in a lab that was not possible face-to-face (Nolen & Koretsky, 2018). The current research conflicts with students' preferences for TLs and NTLs.

NTLs can save institutions money, help spread resources (Chirikov et al., 2020), and allow students to work at their own pace and location (Drysdale et al., 2020; Nolen & Koretsky, 2018). However, science programs are lacking in online education. It is unclear if this could be

due to faculty preference because little research exists on professors' experiences with NTLs and the transition involved. More targeted research that assesses the application of active learning and field exercises in the non-traditional setting would allow for more specific pedagogical recommendations and a more inclusive experience for science students (Barton, 2020).

Theoretical Context

Transitioning from teaching or learning in person to a virtual or online format can be challenging for faculty and students. Faculty may feel vulnerable or lose identity because they are subject matter experts but might not be experts with the required technology for online learning (Cutri & Mena, 2020; Mitchell et al., 2015). Coch and French's (1948) change theory suggested that relearning a task after a transfer or adjustment may be more difficult than learning the task for the first time. Coch and French also found that the more experienced individuals took longer the relearn the task than the more recently trained individuals. Considering science faculty may not have experience teaching online or using NTLs, the transition to using them may require relearning how to teach the concepts they once taught face-to-face.

The theory of knowledge integration learning, developed by Linn and Eylon (2006), is built on the constructivist approach and states that students bring ideas, previous experiences, and beliefs to the science classroom. Science is often divided into disciplines such as Chemistry, Biology, Physics, and others. Linn and Eylon's knowledge integration theory is a unique approach that attempts to connect the nature of science education and blur the lines between the disciplines so the student gains a broader understanding of the world around them. Students tend to separate science context instead of integrating the information as they learn it. Knowledge integration encourages students to connect scientific concepts to social, cultural, educational, or personal experiences and allows them to investigate scientific phenomena.

In addition to the need for science education to connect concepts that the student brings to the class with the new concepts presented in the material, there is a need for students to engage in the highest level of learning, interactive learning (Chi, 2009; Chi & Wylie, 2014). ICAP framework lists the order of importance in learning engagement, including the least effective passive learning, followed by an active learner, then constructive learning, and ending with the most effective learning method, interactive learning. Science laboratories are a form of interactive learning that allows students to interact with the concepts presented in class. Although these theories underpin research on science laboratories, transitions, and change, the transtheoretical model of change (TTM), which builds on the theories mentioned above, served as the theoretical framework for the proposed study.

Problem Statement

The problem is that science is lagging in the advancements of online learning (Varty, 2016), and while technologies are available that remove TL limitations (Alkhaldi et al., 2016), faculty undergo significant changes when transitioning from teaching face-to-face to virtually (Cutri & Mena, 2020) and the experiences of science faculty transitioning from TLs to NTLs are not yet well understood (Barton, 2020). The use of NTLs has the potential to allow more non-traditional students to study and major in sciences through distance education programs. Although student outcomes in virtual courses (Chirikov et al., 2020; Faulconer & Gruss, 2018), student opinions (Drysdale et al., 2020; Faulconer & Gruss, 2018), and the benefits of NTLs (Drysdale et al., 2020; Nolen & Koretsky, 2018) have been explored and it is clear NTLs can be a suitable replacement for TLs (Chirikov et al., 2020; Faulconer & Gruss, 2018), further qualitative study of faculty experiences through this transition is needed (Barton, 2020) to encourage broader adoption of NTLs and support the faculty who make this change. Faculty

teaching courses with labs or field exercises during the COVID-19 pandemic found it challenging to transition the learning outcomes to virtual options (Barton, 2020); however, it is unclear if the challenge was due to the time constraints and rush of the process. Few studies addressing the transition before the pandemic could be located and were limited to specific practices such as virtual microscopes (Brinson, 2017). Understanding the faculty experience of transitioning from TLs to NTLs is essential for furthering the field of online science education, as research has shown that online programs will not succeed if faculty are against the change (Gulbahar & Adnan, 2020; Mohr & Shelton, 2017).

Purpose Statement

The purpose of this transcendental phenomenological study was to describe faculty's experience with change as they transition from using TLs to using NTLs at postsecondary institutions. Transitioning from using TLs to using NTLs will be defined as faculty who have experience teaching TLs face-to-face and have transitioned to teaching NTLs at some point in their careers and continued teaching NTLs for at least an academic year.

Significance of the Study

The current study explored science faculty’s experiences with change as they transitioned from using TLs to NTLs outside the pandemic. Faculty may not have extensive training in teaching on non-traditional platforms (Cutri & Mena, 2020) and may have negative feelings about using NTLs (Barton, 2020). However, research has shown that NTLs can provide the same learning outcomes as TLs (Chirikov et al., 2020; Faulconer & Gruss, 2018), so understanding science faculty’s experiences is needed if the science programs plan to keep up with the increase in online learning (Barton, 2020; NC-SARA, 2022).

Theoretical Significance

Current theories regarding the importance of laboratories in science failed to incorporate the complexity of transitioning TLs to NTLs. The ICAP framework identified the need for interactive learning in education (Chi & Wylie, 2014) but did not consider faculty using interactive learning exercises in a non-traditional setting. The current study included faculty who have used NTLs with interactive learning exercises, and it provided feedback on the transition and found areas for improvement. The TTM did not explicitly address faculty or course format transitions; however, it had been used to examine faculty's readiness to teach online (Mitchell et al., 2015) and was used in the current study to explore the science faculty's experiences with change as they go through the transition, providing valuable insight into successes and challenges. Current theories failed to include the new technologies available to substitute in-person labs with virtual or remote options and how faculty handled these technologies when teaching NTLs. This study took steps to close these gaps and is theoretically significant through the application of the TTM to better understand faculty's transition to the virtual environment in the post-secondary science field.

Empirical Significance

Minimal qualitative studies were in the current literature review examining science faculty experiences with NTLs. In Brinson's (2015) review of 56 articles published between 2005 and 2015, only five researchers interviewed science instructors regarding their perceptions. Of these, the majority interviewed faculty about the effectiveness of specific NTL tools such as E-learning suites (Rajendran et al., 2010), simulation software (Srinivasan et al., 2006), virtual microscopes (Collie et al., 2012), and Crocodile Clips (Gorghiu et al., 2009). Only quantitative post-COVID research could be located where science faculty were surveyed about transitioning

science field exercises online (Barton, 2020) and whether online microbiology labs should be used in the future (Joji et al., 2022). The empirical significance of the current study was that it adds an in-depth examination of the shared-lived experience that science faculty navigated when they transitioned from using TLs to NTLs.

Practical Significance

There are several advantages to NTLs, such as around-the-clock access (Alkhaldi et al., 2016; Chirikov et al., 2020), the ability to repeat exercises, decreased institutional cost (Chirikov et al., 2020; Faulconer & Gruss, 2018), no animal use (Choate et al., 2021), an increase in the number of science professionals to meet industry demands (Chirikov et al., 2020; Drysdale et al., 2020), and a more interactive experience where the focus is on creating conclusions and not routines (Tho et al., 2017). There is overwhelming evidence that students achieve the same learning outcomes in NTLs as in TLs (Chirikov et al., 2020; Faulconer & Gruss, 2018). However, science courses are offered less online than other courses (Varty, 2016), and the reasoning for this discrepancy was not well understood. The current study examined one possible cause for the lack of online science course offerings: the experience with change that the faculty member endured while transitioning from TLs to NTLs. Faculty often play a role in deciding what modality their course will be offered, so their experiences with this transition shed light onto why there are fewer science courses online and provide quality feedback on what transition element is challenging or beneficial for them as faculty members.

Research Questions

The problem is that faculty undergo significant changes when transitioning from teaching face-to-face to virtually (Cutri & Mena, 2020), but this experience for science faculty transitioning from TLs to NTLs was not yet well understood (Barton, 2020). Although student

outcomes in virtual courses (Chirikov et al., 2020; Faulconer & Gruss, 2018), student opinions (Drysdale et al., 2020; Faulconer & Gruss, 2018), and the benefits of NTLs (Brinson, 2015; Chirikov et al., 2020; Drysdale et al., 2020) have been explored and it is clear NTLs can be a suitable replacement for TLs (Chirikov et al., 2020; Faulconer & Gruss, 2018), further qualitative study of faculty experiences through this transition is needed (Barton, 2020). A central question and three sub-questions guided this study.

Central Research Question

What are the shared lived experiences of science faculty transitioning from traditional laboratories to non-traditional laboratories at post-secondary institutions?

Sub-Question One

What experiences facilitated science faculty's transition from the pre-contemplation stage to the action stage as they incorporated non-traditional laboratories?

Sub-Question Two

What processes of change impacted the perception of science faculty towards non-traditional laboratories during their transition?

Sub-Question Three

What experiences of science faculty influenced their plans for usage, or non-usage, of non-traditional laboratory formats after transitioning from traditional laboratories to non-traditional laboratories?

Definitions

1. *Lab Kits*–Lab kits are materials mailed to students' homes as part of NTLs where they use lab kits at home to experiment (DeBoer, 2019; Reck et al., 2019).

2. *Non-Traditional Lab*–NTL exercises occur outside the classroom or laboratory where the instructor is not present (Attardi et al., 2018; Chao et al., 2016).
3. *Traditional Lab*–TL exercises take place in a physical classroom or laboratory where the instructor is present (Attardi et al., 2018; Brinson, 2015).
4. *Virtual Labs*–Virtual labs are either where the student watches an imitation of an actual experiment or where the student virtually controls equipment in the experiment (Attardi et al., 2018; Chao et al., 2016).
5. *Resistance to Change*–Resistance to change is when individuals may have hope for the potential outcome of the change mixed with apprehension about the process (Burke, 2011).

Summary

The problem is that faculty undergo significant changes when transitioning from teaching face-to-face to virtually (Cutri & Mena, 2020), but this experience for science faculty transitioning from TLs to NTLs is not well understood (Barton, 2020). It is clear that students obtain the same learning outcomes in both modalities in introductory science courses (Faulconer & Gruss, 2018), many STEM courses (Chirikov et al., 2020; DeBoer et al., 2019), physiology (Durand et al., 2019; Wilson et al., 2018), anatomical sciences (Massey et al., 2021), physical science (Miller et al., 2018), microscope based courses (Herodotau et al., 2020), chemistry experimental courses (Irby et al., 2018); and engineering courses (Nolen & Koretsky, 2018; Reck et al., 2019), so further qualitative study of faculty experiences through this transition was needed (Barton, 2020). The purpose of this transcendental phenomenological study was to describe faculty's experience with change as they transitioned from using TLs to using NTLs at postsecondary institutions.

CHAPTER TWO: LITERATURE REVIEW

Overview

The TTM (Prochaska et al., 2015) was developed from the change theory (CT; Coch & French, 1948) and provided the framework for the current study. A systematic review of the literature was conducted to explore the history and quality of online education and compare TLs and NTLs in science education. There are multiple forms of NTLs, often referred to as online, virtual, remote, or at-home labs (Brinson, 2015). NTLs are not new, but due to the COVID-19 Pandemic, some faculty have new experiences due to institutions canceling all face-to-face labs (Barton, 2020). Chapter two includes an overview of the study's theoretical framework and research related to science faculty and laboratory experiences. At the end of the chapter, a gap in the literature and current theories will be identified, presenting a viable need for the current study.

Theoretical Framework

The TTM was developed to consolidate over 300 CTs in social and behavioral science (Prochaska et al., 2015). Prochaska et al. developed the model after concluding that no single theory can encompass all elements involved in behavior changes. The TTM has been used in several fields, such as health care, psychology, and education (Prochaska et al., 2015), and to overcome faculty resistance to online learning (Mitchel et al., 2015).

The TTM is a relatively new theory based on the previously established change theory (Coch & French, 1948); therefore, understanding both theories was critical. The TTM included elements from Freudian, Skinnerian, and Rogerian traditions, and many change theories developed over the years (Prochaska et al., 2015). The TTM was selected as the foundation for the current study because it could assist in describing science faculty's experiences with change

during their transition to NTLs from TLs. Faculty experiences were compared to the process of change represented by Prochaska et al.

The current study's framework was the TTM. Data was analyzed on the faculty's experiences with change transitioning from using TLs to NTLs. Research questions addressed the experiences during the transition to online, remote, or at-home labs. The questions were designed to allow the faculty to express their experiences during the transition. The collected data was analyzed for emergent themes of experiences of each faculty member interviewed. The results included emergent themes of experiences and specific statements regarding faculty's experiences that led to the themes.

Faculty considering teaching online or using NTLs face significant changes. When faculty were asked to start teaching online after teaching face-to-face, the lack of a physical classroom was one of the changes they faced. Altering their current teaching styles, educational tools, and resources and possibly exponentially increasing the role of technology in their curriculum where other potential modifications faculty were expected to consider and eventually adhere to (Mitchell et al., 2015). Not all faculty have training in online learning management systems, and the newness caused significant feelings of vulnerability (Henderson et al., 2011).

Related Literature

A thorough review of the literature was completed to fully comprehend the current research addressing topics that would play a role in the faculty's experience with change when transitioning from using TLs to NTLs. Science education is often included in all majors for post-secondary degree requirements, even non-science majors, as it might be a humanities requirement (Varty, 2016). When science courses were shifted to an online platform, the teaching faculty had to transition their material to a virtual format that may be new (Brinson,

2015). Online education is vast and includes many different subjects (Cutri & Mena, 2020); however, science courses may require NTL options when offered online. The laboratory exercises allow students to apply the concepts and topics covered in courses to real-life situations, and research suggests that students perform better in science courses when a laboratory component is included (DeBoer et al., 2019; Goacher et al., 2017).

Human Responses to Change

How individuals approach, handle, and persevere through changes has been studied extensively, dating back to 1948 when Coch and French founded the theory and published *Overcoming Resistance to Change*. Coch and French explained that change is always met with resistance from some individuals and that resistance must be countered for successful organizational change. They found that relearning a new skill after a transfer took longer than the initial learning at hiring operators within a factory. The transfer often resulted in hostile feelings and actions towards management. Interestingly, the researchers found that experienced operators did not recover from the transfer faster than newer hires, often taking longer to relearn skills compared to the initial learning that occurred when hired. Coch and French could not determine the cause of delayed secondary learning but suggested it might be the individual's internal resistance to the forced change. They ultimately concluded that resistance could be decreased if the individuals were involved in the pre-change decision-making process by holding meetings where the change was discussed ahead of time. The sessions allowed employees to voice their concerns and often helped decrease the resistance within the factory.

Since Coch and French (1948), several other versions of change theories have emerged, and the definition of resistance to change has evolved. Research addressing the change theory has led to further developments and modifications to the CT, first founded by Coch and French.

Burke (2011) suggested that the term resistance is an action and not always negative; individuals may have hope for the potential outcome of the change mixed with apprehension about the process. For example, the individual may be knowledgeable about the change and believe it is for the best, but at the same time, be nervous about learning something new.

Principles, Stages, and Processes of Change

James Prochaska (2015) was the lead researcher and headed the development of the TTM because no single theory can encompass all elements involved in behavior changes. Prochaska is the Director of the Cancer Prevention Research Center's Director and a Clinical and Health Psychology professor at the University of Rhode Island. The researchers developed the TTM, which integrates different theories and conceptions into one centralized model (Clark, 2013). In 1982, DiClemente and Prochaska studied individuals attempting to quit smoking (Prochaska et al., 2015). The researchers identified ten behaviors that could be used to predict an individual's success at quitting smoking. These 10 behaviors included elements from three previous behaviorist traditions: Freudian, Skinnerian, and Rogerian. This study ultimately led to the 1983 proclamation of the TTM. The TTM stated that behavior changes occur in six stages of change, where the ten processes occur.

Today, the TTM is a framework used across many fields with a wide variety of populations, including education (Mitchell et al., 2015). The TTM can be considered within three dimensions: temporal, cognitive-behavioral, and individual differences. The temporal dimension focuses on time, whereas the cognitive-behavioral dimension focuses on. The TTM establishes a total of five stages of change and ten processes of change and defines the pros and cons of changing, self-efficacy, and temptation (Prochaska et al., 2015). The stages, processes, and elements of change are discussed below.

Stages. The TTM contains six stages of change: pre-contemplation, contemplation, preparation, action, maintenance, and termination (Prochaska et al., 2008). Individuals will go through each of these stages, usually linearly. Within the stages, the individuals will go through processes of change. First, the stages of change will be defined, followed by the processes of change.

Precontemplation Stage. In the pre-contemplation stage, the individual has not yet committed to the change (Prochaska et al., 2015). Some individuals in this stage may be well-informed but reluctant to commit to the change, while others may not be informed well. In the pre-contemplation stage, individuals may fear the change or fear of not making the change and fear or excitement over the process (Clark, 2013). Also, in this stage, the individuals may self-evaluate to determine if the change is essential to their values. Prochaska et al. suggested that individuals in this stage possibly have no intention of making the change in the next six months.

Contemplation Stage. In the contemplation stage, the individuals are committed to making the change in the next six months (Prochaska et al., 2015). The individuals in this stage would be better informed than those in the pre-contemplation stage. They would be aware of the pros and cons of making the change, which Prochaska et al. suggested may cause a profound ambivalence, making it difficult for individuals to move forward with the changes.

Preparation Stage. The preparation stage, where they plan to make the change soon, is actively preparing for the transition. In this stage, the individuals may have already taken steps toward the change, readying for the transition (Prochaska et al., 2015). Preparation teams may be formed to help distribute information and prepare for the process (Clark, 2013).

Action Stage. Once prepared, the individuals would move into the action stage. In this stage, the individual would be committed to the change and consciously gain awareness about

the problem or task (Clark, 2013). The individuals in this stage could also attempt to change their thinking to succeed in the change process. Here the individuals would be actively engaged in the change and altering their habits and thoughts (Prochaska et al., 2015).

Maintenance Stage. If the action is completed successfully, the maintenance stage will follow. The individuals will take the necessary steps to ensure they can continue with the new behavior (Prochaska et al., 2015). They may have the tools and skills to proceed independently; however, they benefit from ongoing support. The individuals in this stage may still experience challenges but should use the awareness gained through the process not to revert.

Termination Stage. The last stage is the termination stage, where the individual has no intentions of returning to the previous behavior (Prochaska et al., 2015). To progress through the stages of change, the pros of making the change must outweigh the cons of not making the change.

Processes of Change. The stages above are progressed linearly while the individuals go through different experiences. Prochaska et al. (2015) referred to these experiences as the processes of change. In total, there are ten change processes: consciousness-raising, dramatic relief, self-reevaluation, environmental reevaluation, self-liberation, social liberation, counterconditioning, stimulus control, contingency management, and helping relationships. The individuals may not progress through the processes linearly. The processes of change will be defined below as they relate in the literature and to each other, and the stages they occur.

Consciousness-Raising and Dramatic Relief. Consciousness-raising and dramatic relief occur during the pre-contemplation and contemplation stages (Mitchell et al., 2015). Consciousness-raising involves increasing the individual's awareness of the situation or problem. Interventions such as feedback, confrontations, and interpretations may increase an individual's

awareness (Prochaska et al., 2015). Where consciousness-raising is about information, dramatic relief relies on the awareness gained during the previous process and then uses it to increase an emotional response from the individuals. In the dramatic relief phase, the individual would contemplate examples of what might occur if they go through the change.

Environmental Reevaluation. In the environmental reevaluation process, the individuals would involve affective and cognitive assessments of how their choice impacts their environment (Mitchell et al., 2015). In this process, the individual may look at what role model they would be for others if they made the change or did not change (Prochaska et al., 2015). During this process, the individual may look at those around them and evaluate how they can affect their environment; this process would occur during the contemplation stage. This is different from the previous two processes, as they may occur during the pre-contemplation and or the contemplation stage.

Self-Reevaluation and Self-Liberation. Self-reevaluation and self-liberation happen in the preparation stage as the individual plans to change (Mitchell et al., 2015). Self-reevaluation occurs as the individual takes steps towards making the change and combines the previous processes. Individuals picture themselves as if they have gone through the change or failed to complete it. In this process, the individual's values are clarified; they decide if there is value to making the change or if it is essential to their self-value. Positive role models would aid in helping the individual see the benefit of making the change (Prochaska et al., 2015). In individuals serious about changing, self-reevaluation usually leads to self-liberation, where the individual firmly believes they can change and commit to change.

Social Liberation and Helping Relationships. Social liberation and helping relationships mean that the persons attempting to change would experience more opportunities and the

opportunity to change, in addition to more support from those around them. For example, increasing access to education and offering advisors to support the process for young adults from low-income homes (Prochaska et al., 2015). Prochaska et al. also provided the example of adding salad bars in lunchrooms increasing the individuals' opportunity to eat healthily. Both change processes would occur in the preparation and action stages.

Counterconditioning, Stimulus Control, and Contingency Management. Counterconditioning, stimulus control, and contingency management occur during the action and maintenance stages. These processes would be less pertinent to educational applications of the TTM as they are meant to aid the individual in not backsliding during and after the change process (Prochaska et al., 2015). However, rewards, reminders, and social networking could support educational individuals in proceeding with changes (Mitchell et al., 2015).

Decisional Balance Aspect. In addition to the five stages and ten processes, decisional balance is also incorporated into the TTM. Decisional balance weighs the pros and cons of making the change (Prochaska et al., 2015). If individuals' perceived cons outweigh the pros, they will not move forward with the changes. Lastly, individuals must be confident that they will not relapse into the old behaviors when faced with temptations.

Application to the Educational Field

TTM is commonly used in behavioral science to address unwanted negative behaviors such as drug use or smoking. However, TTM has also been used in various fields with applications ranging from education to production (Prochaska et al., 2015). There are sparing arguments that TTM should no longer be used for unwanted behaviors (Brug et al., 2005; West, 2005); however, a quick search of the theory will result in several recent successful studies where TTM was implemented (Clark, 2013).

One study used the TTM to increase interprofessional education (IPE) participation within organizations (Clark, 2012). The study was conducted within a health and social care institution where low participation in IPE was evaluated. The institution selected the TTM as the framework to change and advance IPE. Clark selected the TTM because it recognized the complexity of change, incorporated essential elements from organizational theories, and conceptualized the multiple dimensions needed for change. Clark implemented a new IPE design using the TTM framework and observed increased participation. He notes that the long-term effectiveness of change will depend on a fundamental and significant shift in institutional values.

Mitchell et al. (2015) used the TTM to make suggestions to gain faculty support and involvement in online learning. This is the only example of using TTM directly with education located. Mitchell et al. made recommendations based on the process of change described by Prochaska et al. (2015). One example of a recommendation by Mitchell et al. is that higher education administration should involve faculty in the consciousness-raising process by sending a clear message about what changes are to come and what their role is in the process. Mitchell et al. explained that faculty is both the recipient and agent of change; they must be ready for change and be prepared to change.

Science Education

Science is defined as studying and investigating the natural world (National Academy of Engineering & National Research Council, 2014; Siayah & Setiawan, 2020). Science education includes multiple natural sciences within three fields: earth science, life science, and physical science (Campbell-Phillips, 2020) and would fit under the umbrella of science, technology, engineering, and mathematics (STEM) education, an acronym coined in the 1990s by the National Science Foundation (Tsihouridis et al., 2019).

Science education teaches students about themselves and their bodies, the world around them, and the relationships between the two; science education promotes investigation into new concepts that explain a student's place in the world around them (Linn & Eylon, 2006). Science education allows the students to actively learn by engaging with the content they are working on (Goacher, 2017; Siayah & Setiawan, 2020) and constructively learn through sensory reception and problem-solving (Khalil & Elkhider, 2016; Siayah & Setiawan, 2020). The increased engagement with the material that hands-on learning in science provides also increases science literacy in students (Townley, 2018; Siayah & Setiawan, 2020). Discipline specialists are considered field leaders and function separately; however, research suggests that disciplines should be taught more compatibly (Campbell-Phillips, 2020; Coppola & Krajcik, 2014), and a broader partnership now exists that includes technology, policy, sociology, anthropology, neuroscience, and psychology of learning (National Academies of Sciences, Engineering, and Medicine, 2022; Linn & Eylon, 2006). The students bring a rich background and prior knowledge to each course (Coppola & Krajcik, 2014). When students consider multiple ideas linked to social, cultural, educational, or personal experience, science lessons can set in motion a life of formulating, connecting, distinguishing, and investigating, a life where science is valued (Townley, 2018; Jones, 2018).

Science education affects the economic growth and security of the US (Xie et al., 2015), and the US has fallen behind (Campbell-Phillips, 2020). Previous attempts have been made to increase science educators' quality and number and enhance science education in the US, such as the American Competes Act (Mervis, 2007) and the "Rising Above the Gathering Storm" call to action (Madsen & Tessema, 2009). Today the STEM field is growing rapidly with technological advancements such as big data (Baker, 2017; National Academies of Sciences, Engineering, and

Medicine, 2022), a combination of science and computerized data management in research (Baker, 2017; Gibson & Mourad, 2018). Policy creators, educators, industrial organizations, and business leaders are urging for improvements in science skills to meet the current and future needs within the US (Gibson & Mourad, 2018).

Science occupations are considered prestigious and often yield higher salaries (Xie et al., 2015). Individuals with degrees within the science field are prepared for academics, research, and careers beyond the science field (St. Clair et al., 2017; Zimmerman, 2018). Technologies used in science education make experience possible when location or funding usually limits them, and technology-enhanced environments allow for alternative forms of instruction (Linn & Eylon, 2006). Computational biology is now incorporated into every field of biology (Baker, 2017). If specific demographics of students are being missed with traditional science education, it stands to question if non-traditional means of science education; for example, online courses with NTLs, might bridge the gap to missed groups, increasing the diversity, number, and quality of science professionals. Although the goal of the current study was not to increase NTL options, the faculty's experience with the transition is an essential piece to the more prominent online shift at hand.

Science Faculty

Faculty are scholars who conduct research and instruct as experts in their field of study (Hollman et al., 2018). Science faculty, like most disciplines, are going to include professors, assistant professors, associate professors, instructors, and adjunct professors. These positions can be full-time or part-time, and tenure or non-tenure tracks. Low-paying and heavy workload post-doctorate positions in science research were once considered a mandatory step in obtaining a tenure track researching faculty position at a four-year institution; however, current trends show

that non-post-doctorate professionals research more after ten years in a position and have a higher income (Kahn & Ginther, 2017) and that institutions differ in their research versus instruction expectations of faculty members (Hollman et al., 2018).

Over time, new tenure track faculty positions have decreased, partially due to an increase in science faculty retirement age after the mandatory retirement age law was removed in the 1990s (Ghaffarzadegan & Xu, 2018). This means that science faculty are staying in their tenure position past the average retirement age, which can limit the field for new Ph.D. graduates searching for tenured faculty positions. In 1973, 55% of new biological Ph.D. students found tenure-track positions within six years, compared to 18% in 2009 (Beninson & Daniels, 2018). It is unclear whether the increase in age at retirement and the limited online science offerings are related; however, it is worth considering since newer graduates could be more comfortable with the required technology for online course offerings. These numbers reflect the entire education field as tenure track positions have decreased over the last 30 years, and part-time contingent positions are increasing (National Center for Education Statistics, 2021).

Science Faculty Responses to Change Pre-Pandemic

Institution leaders should engage in change, whether supporting or opposing suggested new proposed ideas; however, they often resist change (Kezer & Holcombe, 2021). One change science faculty have faced is incorporating student-centered learning, which asks faculty who have viewed students as empty vessels needing to be filled with information to see students as seekers of knowledge (Love et al., 2018). Education is evolving, and student-centered teaching is the future. Still, science faculty often approach learning from the vantage point of their experiences as students and teachers (Daumiller et al., 2021). Considering teaching NTLs would require an adjustment in teaching style for most faculty, attempts were made to locate literature

addressing how science faculty may respond when asked to change their current teaching methods, similar to the change that faculty would experience when asked to teach online.

Science faculty are more likely to make decisions based on their experience and not empirical evidence (Andrews & Lemon, 2015; Eddy et al., 2019). Andrews and Lemon found that biology faculty (N = 17) who were asked to implement active learning lessons into their courses stopped using them due to increased preparation time and poor time management during class time, even though empirical evidence showed increased student comprehension. In a separate study, Andrews et al. (2016) found that biology faculty (N = 57) were likely to make changes when discipline-based education researchers within the workplace supported them with time and resources. Several attempts have been made to aid transitions within the science departments, such as the four-frame model of organizational change and grounding projects in the change theory (Reinholz & Andrews, 2020).

Online Education

Online education has become increasingly important, especially with the COVID-19 pandemic occurring in the last couple of years (Akbaba Altun & Johnson, 2022; Ali, 2020). The number of exclusively online learners increased before the pandemic, then dramatically increased during the pandemic, and has since remained higher than the last stable, or pre-pandemic, year (NC-Sara, 2022). Even without the pandemic's impact, the increase is not surprising, as online learners can attend classes from home while continuing their commitments to their careers or family (Cutri & Mena, 2020), making it an attractive option to non-traditional students. NTLs are associated with online science courses; therefore, a thorough understanding of the purpose, benefits, challenges, and perceptions of online learning is first needed. In this section, NTLs are not addressed, as the focus is on online education in general. Although the

COVID-19 pandemic has impacted online education, it is not the only reason for its increase in popularity, so literature researching online education both before, during, and after the pandemic was examined.

Intentions of Online Education

Online education is not new but has significantly changed over the years, originating from correspondence education using a printing press and post office; however, the goal has remained to increase access to education (Anderson & Simpson, 2012). Online pathways to education increase educational access for non-traditional students of all socio-economic groups without geographical, financial, social, or cultural constraints (Peters, 2008; Shah, 2018) and increase the number of professionals produced (Lee, 2017). The COVID-19 pandemic only fueled the need for educational options that offer flexibility when face-to-face learning is not an option (Akbaba Altun & Johnson, 2022; Ali, 2020; Tartavulea et al., 2020).

Measuring the Quality of Online Education

As the demand for online education has increased, a need for a method to evaluate the programs became apparent, but there is no standard assessment or model (Marciniak, 2018; Tartavulea et al., 2020). There are several proposed models, such as Marciniak's model, which includes two variables and 14 dimensions, the Sloan-C quality pillars (King & Nininger, 2019), the quality benchmarks from the Institute for Higher Education Policy (Esfijani, 2018), and the ISO/IEC 40180 Framework for quality assurance (Shraim, 2020), to name a few. With some models, student satisfaction is often used to measure the perceived success of the program, even though research has shown several factors can influence students' opinions of learning, such as incentives, enrollment methods, and environment (Davis et al., 2018). Much of the vocabulary within the models is different. Still, the overall goal of improving online education with

straightforward objectives of increased accessibility, increased flexibility, cost-effectiveness for all stakeholders, and maximal interactive learning was the same (King & Nininger, 2019; Shraim, 2020). Several small-scale studies, because of the pandemic, have now been published with directives to increase the effectiveness of online education (Akbaba Altun & Johnson, 2022; Ali, 2020), though the long-term effects cannot be determined yet, and the use of any of the above models could not be located.

Faculty Experiences and Perceptions of Online Education

Before the COVID-19 pandemic, faculty support for the value and legitimacy of online classes was low (Allen & Seaman, 2015). The preference could be partly due to a lack of support and less teacher-student interaction with online platforms (Smith, 2016; Ubell, 2017) or a lack of exposure to online learning (Allen et al., 2012). Faculty are used to being the field experts and may feel that they lose that title when teaching online (Cutri & Mena, 2020; Mitchell et al., 2015), especially if they are not experienced with the required technology (Cutri & Mena, 2020), or feel like they will miss out on promotions or recognition (Ubell, 2017). However, when institutions resist change or fail to respond adequately, problems can arise (Abdurasulovich et al., 2020). The willingness to accept change is an important requirement for integrating the technology needed for online learning (Ali, 2020).

Proper training and increased flexibility were shown to increase the level of satisfaction in faculty teaching online (Gülbahar, 2020; Stickney et al., 2019). Additionally, quality assurance and best practices were helpful when facilitating the shift to online learning (Mohr & Shelton, 2017). Even though teaching online may allow for an increase in schedule flexibility, additional time may be required for the faculty member to set up and maintain an online classroom (Elshami et al., 2021; Mansback & Austin, 2018) so clear expectations about the time

required are essential for faculty (Mansback & Austin, 2018). Martin, Budhrani, et al. (2019) interviewed eight award-winning online professors and found that they spent more time being present with the students and less time on the structure and formatting of the course, a practice that would be helpful for new online teachers to embrace. Martin, Budhrani, and Wang (2019) surveyed 205 online teachers later. He found that prompt communication, strong time management, and developed technical skills were all attributes that would aid teachers in adjusting to online education. Teachers' confidence in their ability to teach online increased the longer they taught in an online platform (Eddy et al., 2019; Martin, Budhrani, & Wang, 2019).

The COVID-19 pandemic undoubtedly affected multiple areas of education, and many believe those changes may last long past the pandemic (Akbaba Altun & Johnson, 2022; Ali, 2020). Research published regarding the shift to online education during the pandemic suggests the most common problem faculty faced was a decrease in interaction between faculty and students compared to face-to-face classes (Code et al., 2020; Korkmaz & Toraman, 2020). The decrease in communication did cause some faculty to feel the effectiveness of online education was not equivalent to face-to-face (Tartavulea et al., 2020), and some were concerned with their ability to evaluate student learning on the online platform (Korkmaz & Toraman, 2020).

Even with the negative experiences during the transition, such as an increased workload when having to prepare online lessons (Elshami et al., 2021), many faculty felt that online education would increase as a result of the pandemic even after it ended (Akbaba Altun & Johnson, 2022; Korkmaz & Toraman, 2020), and that faculty would be more prepared to teach online as a result of the pandemic (Dempsey et al., 2022; Korkmaz & Toraman, 2020). Several studies suggested critical factors in increasing the effectiveness of online education, such as expanding training to include certification instead of just on-the-job training (Gurley, 2018),

faculty support (Bathgate et al., 2019; Elshami et al., 2021) and changing the mindset, value, and philosophy of online education (Akbaba Altun & Johnson, 2020). Something as simple as a positive learning approach goal of faculty was found to be positively associated with the perceived self-effectiveness and competence of teaching online (Daumiller et al., 2021).

Student Experiences and Perceptions of Online Education

Students' opinions of online learning are based on different variables than professors, such as student satisfaction (Bolliger & Halupa, 2018), presentation style (Ramlatchen & Watson, 2020), or even peer interaction (Raymond et al., 2016). Although teachers felt collaborative learning variables were critical for online courses, students were more concerned with personal learning benefits (Gómez-Rey et al., 2016). Transactional distance is not a physical distance when learning online, but dialogue and connections; the smaller the transactional distance between the instructor and student, the more engaged and motivated students feel (Bolliger & Halupa, 2018).

Students value an online environment that allows for professor and peer immediacy (Ramlatchen & Watson, 2020). Students felt that showing a video of the professor speaking in the corner of a presentation (Ramlatchen & Watson, 2020), using audio–visual presentations with colors, emoticons, and figurative language (Dixson et al., 2017), and incorporating peer learning (Raymond et al., 2016) increase engagement and enhanced their overall learning experience. By moving to an online system, the opportunities for students to engage with each other increase thanks to features like discussion boards and break-out rooms (Raymond et al., 2016). When students choose the platform they prefer, there is no difference in student satisfaction between online, face-to-face, and blended (Wandera, 2017; Yen et al., 2018), suggesting any differences in satisfaction may be due to the student's preference.

Just as the COVID-19 pandemic may have long-lasting effects on faculty's perceptions of online learning, the pandemic will undoubtedly have some effects on students' perceptions as well (Chowdhury & Mahapatra, 2021; McCord et al., 2023). Student satisfaction with online learning during the pandemic was found to be similar to that before the pandemic, with the teacher and teaching methods weighing most on student satisfaction measurements (Shu-Chen et al., 2018; Gomes de Carvalho Neto et al., 2020). Research suggests that the IT system can affect student satisfaction with the course (Elshami et al., 2021; Gomes de Carvalho Neto et al., 2020), with technical issues causing student frustration (Chowdhury & Mahapatra, 2021; Elshami et al., 2021). Interactive elements and recorded lectures were well received by students (McCord et al., 2023), as well as a more flexible schedule (Elshami et al., 2021). However, just as before the pandemic, a decrease in hands-on opportunities (Chowdhury & Mahapatra, 2021; McCord et al., 2023) and decreased person-to-person interaction (Elshami et al., 2021) were noted as limitations of online learning during the pandemic.

Laboratory Exercises in Science

Laboratory exercises have been a part of science education for years and are essential for learning skills and concepts and helping students gain a sense of nature through experimentation (Hofstein & Lunetta, 2004; Kolil et al., 2020; Massey et al., 2021). The laboratory exercises allow students to apply the course concepts and topics to real-life situations (Clough, 2011; Siayah & Setiawan, 2020). Research suggests that students perform better when courses include a laboratory component (DeBoer et al., 2019; Goacher et al., 2017).

TLs

Traditionally, the lab would occur synchronously in a physical lab where the students are in the same room as an instructor and experimenting with hands-on equipment (Alkhaldi et al.,

2016). TLs are often referred to as hands-on labs (Alkhaldi et al., 2016; Esposito et al., 2021) or cookbook experiments (Tho et al., 2017). These were, historically, the only options available to students enrolled in science courses. Some science courses may include field activities involving students interacting with nature (Fleishner et al., 2017). These would also be considered TLs.

Benefits. There are specific criteria that the National Science Education Standards have set forth to describe precisely what a student should know to achieve scientific literacy (Glaze, 2018). A student may learn about Taxonomy within the living kingdom, which is how organisms are classified into kingdoms, phyla, and species. These dividing traits have evolved from simple single-celled organisms into complex mammals such as humans. However, pictures do not allow students to interact with a genuine fossilized skull of an extinct species or a preserved extant species. Experiences like these make laboratory learning outcomes critical to the success of a science student (DeBoer et al., 2019; Goacher et al., 2017). Many feel these experiences are difficult to transition to a virtual format (Barton, 2020).

Challenges. TLs have several limitations (Faulconer & Gruss, 2018). Laboratory materials tend to be costly and can strain institutions' financial budgets (Chiricov et al., 2020; Faulconer & Gruss, 2018). They use real animals as lab specimens for dissections, which is emotionally challenging for some students (Choate et al., 2021). Additionally, the materials in a TL can only be accessed when the room is open (Alkhaldi et al., 2016; Chirikov et al., 2020). Due to time constraints, TLs are typically more accessible to traditional students, limiting non-traditional students' options (Drysdale et al., 2020). Lastly, TLs have been said to be focused on routines and procedures instead of creating conclusions and critical thinking (Tho et al., 2017).

NTLs

NTL is a generalized term used for various lab exercises outside the TL setting (Alkhaldi et al., 2016; Brinson, 2015, 2017). As online education has expanded and gained popularity, the STEM field has been challenged because of the need to provide an equivalent laboratory experience (Rowe et al., 2018). There are several types, including online, remote, virtual, and at-home lab kits (Alkhaldi et al., 2016; Faulconer & Gruss, 2018). NTLs may occur where the student controls the equipment virtually or as simulations the students observe. Although TL work has been the standard practice for years, these non-traditional versions are rising in popularity (Tsichouridis et al., 2019).

Defining Types of NTLs. Several NTLs occur outside the school's building and are less commonly referred to as non-traditional practical work (Drysdale et al., 2020). NTLs are categorized based on the experimenter's position in relation to the equipment and the technology involved. Research often generalizes NTLs as online labs (Brinson, 2015; Chirikov et al., 2020); however, this terminology fails to include if the student or computer controls the experimentation.

***Virtual Lab*.** The virtual lab is when the student is observing an actual or simulated lab on a computer or device; the student is not in control of the equipment (Faulconer & Gruss, 2018; Hernández-de-Menéndez et al., 2019). These are often called online or web-based laboratories (Esposito et al., 2021). The student would not input any data or commands, and data would be collected from the video observation. The virtual labs could include pre-recorded videos of labs or simulations. The key is that the student is not controlling any of the variables or outcomes. Typical examples are TEALsim, E-Space, ChemCollective, and others (Hernández-de-Menéndez et al., 2019).

***Remote Lab*.** Remote labs are when the student participants in an actual or simulated lab; the student controls the equipment remotely (Esposito et al., 2021; Hernández-de-Menéndez et al., 2019; Post et al., 2019). Remote labs could include computer simulations using software or live video labs where the student communicates through video with the instructor. The student may have options for what variables to use and settings to experiment with; they will have real-time results to record. This type of lab may also include virtual reality labs where the student controls the virtual equipment (Drysdale et al., 2020; Hernández-de-Menéndez et al., 2019). There are several examples of software designed for remote labs such as the Massachusetts Institute of Technology's iLab (Hernández-de-Menéndez et al., 2019), Labster (Jones, 2018), ReLOAD, and NetLab (Hernández-de-Menéndez et al., 2019).

***At-Home Lab Kits*.** At-home labs occur in the student's choice of location, most often their home (DeBoer et al., 2019; Choate et al., 2021). Unlike virtual labs or remote labs, students using a lab kit will experiment using actual tangible equipment, blurring the lines between TL and NTL. The students will have printed instructions or videos to help them with the process and record their results. This lab format fills the need for learned skills using equipment missing from virtual labs; however, the logistical challenges and increased cost must be considered.

Benefits. NTLs can save universities money by decreasing the cost of materials and maintenance over a TL and help spread resources and instructors (Chirikov et al., 2020; Drysdale et al., 2020; Nolen & Koretsky, 2018). In addition, NTLs have a significant potential for growth because resources can be stretched further and increased accessibility (Faulconer & Gruss, 2018), allowing virtual experiences that are simply not possible in the lab (Tsichouridis et al., 2019). Providing laboratory experiences to non-traditional online students has taken on new considerations with the rise of online courses, and they are being used today more than ever

(Reck et al., 2019). This increased availability can also produce more STEM graduates as the field is opened to non-traditional college students (Drysdale et al., 2020).

In addition to financial benefits, there are educational benefits as well. NTLs allow students to self-pace, restart, reset, and repeat activities around the clock, whereas TLs are limited to lab hours (Alkhaldi et al., 2016; Hernández-de-Menéndez et al., 2019). With less focus on the process and equipment, the students can create conclusions and connect concepts (Tho et al., 2017), modify or simplify real-world situations into visible displays adapted to various cognitive levels (Heradio et al., 2016), and increase student originality, input, ownership, or design (Tho et al., 2017). Students feel less anxiety working with virtual chemistry equipment (Heracio et al., 2016; Kolil et al., 2020) and can still feel connected virtually when interacting with each other in real time with microphones, headsets, mouses, and keyboards (Winkelmann et al., 2017). Teaching assistants reported that virtual microscopes were easier to use and increased student collaboration in biology (Collier et al., 2012). An additional, less obvious benefit to NTLs is the virtual option for dissections; instead of preserved specimens (Arslan et al., 2020; Choate et al., 2021), an essential consideration in the animal welfare movement.

Challenges. NTLs do not come without their unique challenges. Faculty suggest that excessive use of virtual experiments could be detrimental to students' future laboratory skill sets, specifically the skills for using laboratory equipment (Chao et al., 2016). Perhaps the most cited challenge for faculty and students when using NTLs is the lack of collaborative features (Heradio et al., 2016; Purkayastha et al., 2019). However, there are several documented efforts to combat the sense of separation. One example is using NTLs within a Learning Management system, where the students can discuss the results and experience with each other on discussion boards (Heradio et al., 2016; Purkayastha et al., 2019). Additionally, concerning faculty, NTLs can be

time-consuming to create (Elshami et al., 2021; Martin, Budhraani, et al., 2019). Accessing pre-created ones would be beneficial; however, platforms to organize the available options and allow instructors to locate them more easily are not heavily used (Zervas et al., 2015) and are limited to a few learning management systems (Lowe et al., 2016).

Technology use has both benefits and challenges, and technology issues can cause frustrations among faculty and students (Elshami et al., 2021) and decrease the authenticity of the experience (Moosvi et al., 2019). The use of virtual reality technology has increased in NTLs, and while the students using the virtual reality equipment felt more immersed in the lab, they may acquire less knowledge (Makransky, Terkildsen, et al., 2019). The availability and use of technology can also differ from one institution to the next (Esposito et al., 2021). However, the same can be said for physical equipment in a TL.

Comparing Student Outcomes and Engagement Pre-Pandemic

Comparing learning outcomes between the different lab modalities is challenging because no general census measures learning outcomes (Hernández-de-Menéndez et al., 2019). Regardless, several reviews (Faulconer & Gruss, 2018; Hernández-de-Menéndez et al., 2019) claimed that NTLs are as effective as TLs for student learning outcomes. Researchers noted that studies producing positive outcomes for virtual labs seem to focus on content knowledge; in contrast, studies supporting face-to-face labs relied more on qualitative data related to student perceptions (Hernández-de-Menéndez et al., 2019). Some studies suggest it is best to use both together instead of one (Brinson, 2015; Herodotou et al., 2020) with the potential to optimize science learning (Chao et al., 2016).

Overall, students enrolled in NTLs do as well as, or better, than students enrolled in TLs in terms of student achievement and or perceived learning (Faulconer & Gruss, 2018; Post et al.,

2019) and student outcomes (Chirikov et al., 2020). These specific outcomes can be found in courses such as Microbiology (Brockman et al., 2020; Herodotou et al., 2020, Makransky, Amyer, et al., 2019), Human Anatomy and Physiology (Massey et al., 2021; Wilson et al., 2018), Engineering (DeBoer et al., 2019; Reck et al., 2019), Physical Science (Miller et al., 2018), Physics (Moosvi et al., 2019), Geoscience (Klippel et al., 2019), Chemistry (Irby et al., 2018; Kolil et al., 2020), and Biochemistry (Barrow et al., 2019). Additionally, students' final grades were found to be correlated to their previous GPA in science courses and not the laboratory platform (Attardi et al., 2016).

Lab kits blur the lines between NTLs and TLs because they offer hands-on activities without the confinements of the TL (Choate et al., 2021; Faulconer & Gruss, 2018). Students who used lab kits in their class had higher grades than those that did not (DeBoer et al., 2019) and those that used virtual computer-based labs (Rowe et al., 2018), supporting the concept that there are benefits to including hands-on elements with lab kits for distance learners.

Considerations beyond the immediate class were found to vary with barriers and enablers to both platforms (Regmi & Jones, 2020). Pre-med biology majors taking online courses were found to be less knowledgeable about medical school requirements than students taking face-to-face classes (Cooper et al., 2019). However, engineering students taking courses with NTLs reported higher interest in the field and operations than face-to-face students (Nolen & Koretsky, 2018). Conflicting evidence suggests that students' experiences, satisfaction, and preferences may largely depend on the instructional design (Regmi & Jones, 2020), whereas student performance is more agreeable.

Faculty Preference for Laboratory Pre-Pandemic

There is a minimal amount of research on faculty perceptions of the available options for NTLs and the tools used in them. However, faculty have reported feeling less of an expert and losing identity when using NTLs (Cutri & Mena, 2020). After reviewing literature regarding both virtual and physical investigations, de Jong et al. (2013) concluded that while both could meet the goals of higher investigation in science courses and allowed the student to experience sophisticated equipment outside the school's means, they felt the excitement of conducting hand-on experiments could not be replicated virtually.

Blended learning was suggested as an alternative to only online options (Tsihouridis et al., 2019), perhaps providing the best of both options. Crocodile Clips is a virtual simulation software often used in NTLs; faculty using the software felt implementing it into the classroom was time-consuming; however, all faculty reported that students' understanding increased due to the lesson (Gorghiu et al., 2009). In this study, the students were enrolled in TLs, but benefits to using the Crocodile Clips were observed. Virtual chemistry options offer a safe choice with less anxiety about possible injuries (Gorghiu et al., 2009; Kolil et al., 2020). Teaching assistants also supported the use of virtual microscopes, explaining that they were easier to use, allowed the students access to the material at any time, and increased student collaboration (Collier et al., 2012). The students in this study were not distance education students, but as with the Crocodile Clips, it showed positive faculty feedback on a tool that could be used in NTLs.

Students' Preference for Laboratory Pre-Pandemic

Student preferences were found to be less researched than student performance; opinions seem to vary, with some preferring TLs (Attardi et al., 2016; Durand et al., 2019) and others NTLs (Post et al., 2019). Students in microbiology reported higher satisfaction and engagement

in the face-to-face lab (de Jong et al., 2013) and a preference for a blended lab experience over online only (Brockman et al., 2020; Herodotou et al., 2020). Even though learning was the same, students preferred real microscopes and dissections in medical school (Kao & Leo, 2018; Wilson et al., 2018) and real equipment in physics (Moosvi et al., 2019). Measuring student preference proves difficult as students have not always been exposed to both types of labs in the course and have displayed a preference for the format they were currently using (Brockman et al., 2020), suggesting satisfaction with both formats.

Research also seems to measure satisfaction more often than preference, with categories such as motivation and self-efficacy (Post et al., 2019). In their review of 23 articles, Post et al. found that most students in all studies were highly satisfied with their online labs, highly appreciative of the unlimited access, and reported a high learning benefit. Satisfaction seems to be supported by no differences in motivation or self-efficacy in microbiology (Makransky, Mayer, et al., 2019), positive feedback for biochemistry course design (Barrow et al., 2019), no difference in the enjoyability of science courses (Tsichouridis et al., 2019), and positive learning experiences in geoscience (Klippel et al., 2019).

COVID-19 Pandemic Effects on Laboratories

When universities started to shut down to protect students and staff during the COVID-19 pandemic, science faculty scrambled to create substitutes for their face-to-face laboratories (Blizak et al., 2020; LeSuer & Reed, 2022; Skliarova et al., 2022). Faculty whose NTL experience is limited to the initial pandemic shift in the spring of 2020 will not be included in the study. However, qualifying faculty with NTL experiences may also have experienced NTLs due to the pandemic. For this reason, research involving NTLs during the pandemic was located. Science faculty likely already had preferences for one lab format over the others before the

pandemic; however, these preferences could have been reiterated, modified, or relinquished during the pandemic (Barton, 2020).

Examples of NTLs During the Pandemic

The pandemic forced faculty to develop new ways to conduct labs over a distance. One of the more creative approaches was Novo et al. (2021), where faculty packaged invertebrate specimens in jars of solutions or dried specimens such as shells in boxes and allowed students to pick up the boxes from school and conduct the labs in their homes using USB microscopes. These findings supported Delgado et al. (2020), who noted that the use of virtual options for a microbiology course was well received by students and resulted in no learning loss. In a similar situation, a genetics course was also able to opt for online simulations where students completed labs step by step followed by a real-time demonstration by the instructor (Zhou, 2020). Zhou explained that the online exercises allowed students to participate in and observe experiments; however, the hands-on experiences would still be necessary for some majors. Lastly, Thibaut and Schroeder (2020) successfully implemented a substitute online lab for biochemistry during the shutdowns. Thibaut and Schroader used the built-in discussion board feature and assigned small groups case studies to work through together and turn in a report. The researchers found no loss of learning outcomes with online substitutes. There are several sources available for lab simulations available online, such as Labster (Alvarez, 2021; Senapati, 2022), Beyond Labz, PraxiLabs (Senapati, 2022), McGraw Hill Connect Virtual Lab, HHMI Biointeractive, Learn Genetics, Virtual Interactive Bacteriology Lab, and Biology Corner (Alvarez, 2021).

Faculty Experiences During the Pandemic

Overall, the pandemic presented challenges for many educators, especially those with laboratory components in their courses (LeSuer & Reed, 2022; Robnett et al., 2022; Skliarova et

al., 2022). Choate et al. (2021) interviewed physiology faculty (N = 10) forced to transition their labs to virtual during the COVID-19 pandemic. Of the 10 faculty, seven directly stated, and the other three implied that traditional face-to-face labs are worth offering, when possible, regardless of the financial constraints. Choate et al. reported that the faculty members felt that remote laboratories would not be as authentic as on-campus laboratories, support social engagement and active learning, and would not achieve laboratories' learning outcomes. Barton (2020) found that only 30% of surveyed faculty (N = 117) teaching a course with field-related learning outcomes felt they found a suitable virtual substitute for the activity during the pandemic and that almost 80% of faculty reported adverse effects of the transition, including removing learning outcomes, less student-centered actives, and poor-quality substitutes for field activities.

These findings supported the faculty's preference for face-to-face labs (Joji et al., 2022). The preference could be due to, at least in part, that the pandemic forced many faculty who previously had no experience or intentions to teach virtually to embrace the technology and jump online in a very rushed timeline (Kadtsyna et al., 2022; Skliarova et al., 2022). Some faculty felt odd lecturing in an empty classroom (Schwarz et al., 2022) and being forced to study, test, and apply online models (Skliarova et al., 2022). Most feedback suggests that the COVID-19 shift to online learning and NTLs did not allow for faculty training and therefore was challenging to navigate (Ray & Srivastava, 2020). However, due to the forced transition, faculty are now more comfortable with the technology and better prepared to use online platforms and NTLs in the future (Glassey & Magalhaes, 2020; LeSuer & Reed, 2022).

The above findings are supported by the fact that faculty with previous experience with NTLs could navigate the transition with less challenges than those without experience with NTLs (Puzzifero & McGee, 2021; Skliarova et al., 2022). Perhaps the most noted benefit to the

transition is that faculty can now use NTL options alongside face-to-face labs and increase student learning (LeSuer & Reed, 2022; Méndez Ruiz, & Valverde Armas , 2022; West et al., 2021). Recent studies examined the results of the sudden shift to NTLs during the pandemic in one course or one school (i.e., Hsu & Rowland-Goldsmith, 2021; Lorusso & Shumskaya, 2020), but how the pandemic may have affected faculty's use of NTLs is not yet clear.

Student Experiences During the Pandemic

Not surprisingly, student opinions of the virtual options offered during the pandemic varied (Nesenbergs et al., 2021). Several studies reported students having negative perceptions of NTLs and a preference for face-to-face labs (Hsu & Rowland-Goldsmith, 2021; Joji et al., 2022; Skliarova et al., 2022). There were a few cited reasons for this preference, such as a decrease in faculty presence, technical problems (Skliarova et al., 2022), and decreased student participation through the term (LeSuer & Reed, 2022).

Directly conflicting with the findings above, other research found positive outcomes in student performance (Nesenbers et al., 2021; Usman et al., 2020) and student engagement (Nesenbergs et al., 2021). In addition, other studies reported students having a positive experience with the virtual labs they transitioned to (Caño de las Heras et al., 2021; Lorusso & Shumskaya, 2020), text-based chatting (Robnett et al., 2022), video conferencing (Baldock et al., 2021) and asynchronous videoed classes (Schwarz et al., 2022). As with faculty, research suggests that students already using the required technologies had an easier time with the transition (Baldock et al., 2021). A third situation was reported where the students felt they gained the same concept knowledge in the new virtual lab as the previously used face-to-face lab but feedback on gained skills was mixed between success and a lack of skills (Marincean & Scriber, 2020; Usman et al., 2020).

Summary

Learning outcomes did not differ between TLs and NTLs (Alkhaldi et al., 2016; Faulconer & Gruss, 2018); however, some students and science faculty still preferred TLs (Attardi et al., 2018; Wilson et al., 2018) and there were less science course options online in comparison to non-science (Varty, 2016). Faculty, in general, were said to be resistant to change but, with adequate training and support, may be less resistant (Andrews & Lemons, 2015). It was unclear if the faculty valued using NTLs and what experiences may have led to their opinions. The TTM was founded in response to the multiple change theories developed over the years because no one CT could encompass all the processes involved with change (Prochaska et al., 2015). Since its development, the TTM has been used in several fields, including healthcare and education (Mitchell et al., 2015; Prochaska et al., 2015). The TTM was the framework for the current study to describe undergraduate science faculty experiences transitioning from using TLs to NTLs. The purpose of this transcendental phenomenological study was to describe faculty's experience with change as they transition from using TLs to using NTLs at postsecondary institutions. The current study added qualitative data representing science faculty who have undergone the transition and aided in developing a better understanding of possible support needed to aid in future transitions. The current study also expanded current theories to include the complexity of offering online science courses with NTL options.

CHAPTER THREE: METHODS

Overview

This transcendental phenomenological study described science faculty experiences with change when transitioning from using TLs to NTLs at post-secondary institutions. In this chapter, the research design section includes a justification for selecting the transcendental phenomenological methodology. Then, the research questions and participant and setting sections follow. The researcher's positionality and role, including interpretive framework and assumptions, followed by the procedures, including the data collection plan, analysis, and data synthesis are discussed. Lastly, the methods for establishing credibility and ethical consideration are included, ending with the chapter summary.

Research Design

A qualitative method was used for this study. Qualitative researchers are not bound by tight perimeters or approved methodology and can look more in-depth at the complex interactions of elements in the situation (Creswell & Poth, 2018). Human experiences, such as faculty experiences with transitioning to NTLs, are challenging to measure with a scale or ruler as done in quantitative studies; therefore, a qualitative approach to this study allowed for detailed descriptions from the participants. Understanding faculty's experiences with the transition has not been described outside a few studies before 2015 (Brinson, 2017) and a few quantitative surveys during the pandemic (Barton, 2020). Complete understanding is best accomplished via qualitative methods, which maintain the individuality of the human's perspective in the study and discuss the essence of the experience (Moustakas, 1994). In addition to the rich descriptions qualitative research produces, it was also appropriate in this study because it collects data from participants in their natural settings. A qualitative researcher looks at the phenomenon in the

natural setting and interprets the experience's meaning or significance to the person (Denzin & Lincoln, 2005). Science faculty are essentially in their natural environment when teaching labs. Qualitative research collects several forms of data in the natural setting, considers participants' comfort, and often refers to participants as co-researchers, as their significant role in the research (Creswell & Poth, 2018). A qualitative approach established a detailed description of the faculty member's experience with change as they transition from using TLs to NTLs.

Several qualitative research methods could have been used in this research; however, only phenomenological studies examine a group of people's shared experiences and insight due to the experience (Kockelmans, 1967). The phenomenological approach began with Edmund Husserl (1859–1938), a mathematician who defined phenomenology as the science of the essence of consciousness (Creswell & Poth, 2018). Later, philosophical writers further explained phenomenologically as exploring a shared lived experience between participants and the descriptions of the essence of the experience without statistical analysis (Moustakas, 1994). What appears in the consciousness during the experience is the phenomenon, and the researcher collects evidence of what participants experienced and how they experienced it (Moustakas, 1994) or the very object of human experience being studied (Creswell & Poth, 2018). Phenomenology was the appropriate choice for the current study because participants had shared the lived experience of transitioning from TLs to NTLs, which is the phenomenon.

There are two standard methods of phenomenological research: hermeneutical and transcendental (Creswell & Poth, 2018; Moustakas, 1994). Hermeneutical uses the researcher's interpretation, whereas transcendental focuses on describing the experience (Creswell & Poth, 2018). When studying only material things, the people, or participants, are often ignored. Transcendental phenomenology was developed to include individuals' experience (Moustakas,

1994). Transcendental phenomenological researchers are personally invested in the research topic and may have certain assumptions and beliefs related to the research. However, they remove themselves and treat the study as if it is their first exposure to the experience. A transcendental phenomenological approach was best for the current study to describe the faculty's experience with change as they transitioned from using TLs to NTLs and gave voice to those who have persevered through the transition before.

Research Questions

The problem is that faculty undergo significant changes when transitioning from teaching face-to-face to virtually (Cutri & Mena, 2020). However, this experience for science faculty transitioning from TLs to NTLs was not yet well understood (Barton, 2020). A central question and three sub-questions guided this study.

Central Research Question

What are the shared lived experiences of science faculty transitioning from traditional laboratories to non-traditional laboratories at post-secondary institutions?

Sub-Question One

What experiences facilitated the science faculty's transition from the pre-contemplation stage to the action stage as they incorporated non-traditional laboratories?

Sub-Question Two

What processes of change impacted the perception of science faculty towards non-traditional laboratories during their transition?

Sub-Question Three

What experiences of science faculty influenced their plans for usage, or non-usage, of non-traditional laboratory formats after transitioning from traditional laboratories to non-traditional laboratories?

Setting and Participants

This section will describe the setting and participants for the current study. A formal bounded setting was inappropriate for this study, as the faculty members teach online and reside throughout the country. The participants were purposely selected based on their experiences with NTLs and interviewed virtually using the Teams application.

Setting

Virtual interviews were the best option due to the participants' locations and the COVID-19 pandemic. The science faculty members teach throughout the country online for different institutions, but one target institution was chosen to recruit participants. Data was not collected physically at the universities, and participants were able to discuss the transition at any institution they had experience with. The organization was purposely chosen as it employs numerous science faculty, both full-time and part-time, and offers science courses online with NTLs. The institution is regionally accredited. The institution has online science courses incorporating NTLs and agreed to participate in the current study. A pseudonym is used to protect the privacy of participants and the institution. The institution served as a recruitment site only, and particpant's expriences were not limit to this instition. However, since some particpants did share their experience at this instition, the recruitment institution is described here.

The U.S. National University (USNU) was purposely chosen. USNU is a distance-only institution with approximately 87,000 active students. USNU is a private for-profit organization.

The entire USNU faculty, staff, and student body are located remotely worldwide. The STEM director oversees each department. Natural science and social science are confined to different departments, with each director. There are biology, chemistry, physics, and geology within the Natural science department. USNU employs both full-time faculty and part-time adjuncts. According to the USNU website, the organization offers a bachelor's degree in natural science with a concentration in biology. Non-biology majors can also take Introduction to Biology to fulfill the general education requirements for sciences. General science course offerings can be found on their website and are taught entirely online with remote at-home lab exercises.

Participants

Efforts were made to maximize variation among participants regarding race, gender, age, and institution; this prevented the saturation of one type of participant while providing full access to various participants and data saturation. Years of experience requirements speak to the era of a style of education they were taught and have used in much of their teaching career. Data saturation is when data has been collected or analyzed to the point where further data collection is unnecessary (Saunders et al., 2018). Only faculty with at least one full teaching year with NTLs were considered. Faculty must have met one or both criteria to be selected: one full year teaching NTLs before 2020 and the pandemic or one full year teaching NTLs during and after the pandemic. Requiring one full year of teaching NTLs, excluding the spring of 2020 pandemic transition, excluded any faculty who only have experience with NTLs due to the pandemic. The transition to NTLs due to the pandemic was unavoidable and unplanned; this may result in unfair negative perceptions that do not apply to the study's intent. A pilot study was conducted to ensure the validity of interview questions.

Researcher Positionality

All researchers bring their own experiences and assumptions to their studies. Creswell and Poth (2018) encouraged researchers to include these experiences and assumptions in their reports. As a biology faculty member who has transitioned from TLs to NTLs, I have the experience to participate in the current study. I am passionate about equal opportunity in science education and invested in the future of NTLs. I have experienced the science faculty's resistance to NTLs and founded the current study to investigate their reasoning and ensure my observations are not limited by exposure. Positionality requires that the researcher acknowledge their views, values, and beliefs to identify, construct, critique, and articulate their positionality (Darwin Holmes, 2020). The current study was conducted with a postpositivist lens.

Interpretive Framework

The current study was grounded in the postpositivism paradigm. The postpositivism framework includes a specific logical data analysis outline in Moustakas (1994). In practice, I inquired about the experiences of science faculty with NTLs in a series of logically related steps. Postpositivism is the most logical framework to include multiple levels of data analysis for the study's rigor, analysis, and validity. Postpositivist researchers often use computer programs to assist in their analysis (Creswell & Poth, 2018); no computer software was used in this study.

Philosophical Assumptions

Philosophical assumptions are unavoidable to researchers. In phenomenological studies, researchers must outline their beliefs about ontology, epistemology, and axiology (Creswell & Poth, 2018). Ontology asks about the nature of reality and recognizes that reality is not a single lens. I realized that in the current study, there were a range of experiences related to their history as a student and faculty members; however, their history cannot be a predicting factor in their

experience. Epistemology inquiries about knowledge, and the researcher attempts to lessen the space between them and the subject. In the current study, I was familiar with the vocabulary and processes that the faculty could have gone through when transitioning TLs to NTLs, so I understood the experiences the faculty shared. In addition to ontology and epistemology, the researcher must also define axiological assumptions. Here, the role of the researcher's values is questioned, and biases are identified in the study. Although I am a current biology adjunct faculty member at the participating institution, I do not have personal relationships with faculty members or any of the participants. My position is remote, and as a contract adjunct, my interactions with other faculty are minimal.

Ontological Assumption

As a Christian, I believe there is only one reality. I feel that the human's view of reality is limited, and we do not fully comprehend the truth of reality. I recognized that my personal view of reality is not based on my scientific background and often contradicts others in my field. Many scientists may believe there is only one Earth, but its origin is debated. Evolution is another debated topic between my faith and my profession. However, the source of Earth or evolution was not a topic within the current research. No ontological assumptions were discussed in the interviews as the topic was a professional transition and not based on one's beliefs.

Epistemological Assumption

My expertise in NTLs was gained through teaching online courses that used various NTLs. I have also taken one anatomy course that used at-home lab kits. As a researcher, I acknowledged that participants' experiences will differ from mine and affect their knowledge of NTLs. I am still considered a younger faculty member who went through undergraduate and graduate programs with heavy use of technology and online platforms. Many science faculty

members are more advanced in their careers and would have completed their degrees before me. Their experiences as a student would significantly differ from mine and affect their knowledge of NTLs. As a younger faculty member, I also have less experience with TLs because I have taught on-campus courses for a shorter period.

Axiological Assumption

As a biology faculty member using NTLs, I bring core values that I believe are critical to science education. All students must have basic knowledge of living science as it affects them personally and their world. I believe non-traditional college students should have the same access to science majors and careers as traditional college students. I effectively bracketed these core values and beliefs to seek the truth of participants' experiences.

Researcher's Role

As the researcher, I served as a human instrument through which qualitative data was collected (Moustakas, 1994). As a biology faculty member who has participated in TLs and NTLs, I had experience with the types of laboratories in question. I have taught TLs and NTLs and have worked with faculty who expressed informal opinions on NTLs. I am a full-time assistant professor at a local small liberal arts institution where I teach mainly in-person biology courses and the occasional introductory level online course. The institution I am employed with full-time will not participate in the current study. I am also an adjunct online professor at two other schools. I do not have a close professional relationship with most faculty at online institutions because of the nature of a remote adjunct contract position. Having a working relationship with the large and diverse institutions was beneficial as it gave me access to the science faculty and encouraged participation. The university that participated was a prime target

for the current study and fit the parameters regardless of my professional connection. I had experience with USNU lab kits and virtual simulations.

Epoché is the first step of phenomenological qualitative research and requires the researcher to refrain from judgment (Moustakas, 1994). As the researcher, I prevented any bias from infiltrating the study to the best of my ability. A researcher should be personally invested in the research topic. Therefore, it is natural for them to have certain assumptions and beliefs related to the research. Still, they must approach the subject as if it is their first exposure to the experience. I approached the data collection and analysis without focusing on my experience with NTLs. Moustakas explained that researchers must refrain from judgment and fully understand their place within the examined experience.

Interview questions were predetermined, and unless the participants chose to elaborate, questions were not diverged. If additional questions were needed to understand participants' responses better, I maintained open-ended, non-leading, and generic questions. Even if asked, I refrained from sharing my experiences with the types of laboratories during the interview. As part of the data collection process, I gained knowledge of NTLs and extended my understanding of the phenomenon (Kvale, 2005). After I developed an interpretation of the interviews and used the member-checking process (Harper & Cole, 2012). The participants were given a chance to review the interpretations. If the participant felt their responses had been misinterpreted, they were allowed to choose to have the data revised or removed. The review process prevented any misinterpretation of data.

Procedures

Permission from the director of the science department was obtained, and directions for submitting the necessary IRBs were explained. Once Liberty University approved the IRB, I

applied for the site's IRB. Participants were solicited once all IRBs were approved, and data collection began. After data collection, the analysis began, and the results were triangulated.

Permissions

Approval from the individual science directors had been obtained, and directions for accessing the appropriate IRBs were provided. All institutions required their own IRB approval before beginning. Once the IRB approval letter was received from Liberty University (see Appendix A), I applied for IRB at the participating institution. The approved site IRBs is in Appendix B.

I selected participants using a recruitment email (see Appendix C) and a questionnaire (see Appendix D). If selected for an interview, a second email (see Appendix E) was sent to them with a consent form attachment (see Appendix F) and a link to schedule their interview through Outlook Calendars and requested them to send an example of an NTL they have used previously. The consent form informed participants of the process, risks and benefits, their right to privacy and confidentiality, their permission to record the virtual meeting, their preference for video or audio-only recording, and their right to withdraw from the study at any time.

Before the interview began, participants were reminded that the interview should take approximately an hour. They were also reminded that they could withdraw from the study at any point and that their data collected to that point will be destroyed. The participants understood that their responses may be used in the published research. They were informed they would have a chance to review interpretations made during analysis before the study is published through the member-checking process.

Recruitment Plan

I sent an invitational email (see Appendix C) to all listed science faculty members of the

institution explaining the purpose and process of the study by the science department chair. The email contained a linked questionnaire (see Appendix D) with Survey Monkey asking potential participants for demographic information and a brief history of their laboratory experiences. Within the email, the individual was asked to please forward the email to any science faculty not included in the original outreach that they feel may be eligible for the study. A duplicate of the invitational email was sent as a follow-up email fourteen days after the first email to individuals who have not responded, reminding them to please review the email and submit the questionnaire if they are interested in participating.

Participants were selected through purposeful criterion sampling (Creswell & Poth, 2018). The critical criterion for phenomenological research participants was to ensure the individuals had gone through the experience and are willing to devote the time and resources for a lengthy interview and follow-up (Moustakas, 1994). The number of participants in phenomenological studies varies. Creswell and Poth recommended between three and 10; therefore, 10 to 15 participants was the original goal to provide varying years of experience among participants. Ten participants were purposely selected using the information on the questionnaires (see Appendix D). Attempts were made to choose a range of faculty with varying years of experience and a demographically diverse group of participants. Once selected, participants were emailed the consent form (see Appendix F) outlined above under permissions. Individuals were purposely selected based on their experience with NTLs.

Epoché (Bracketing)

Epoché is a Greek word that means to abstain or stay away from (Moustakas, 1994), often referred to as bracketing (Creswell & Poth, 2018). Moustakas directed researchers to refrain from judgment and remove themselves from the study. Husserl (1931) explained that

while you can look at scientific discoveries with wonder, the researcher must disconnect from them and not use them in the research. Moustakas encourages researchers to approach epoché as an experience, a chance to gaze upon an experience with newness and gain new knowledge. With epoché, an experience is viewed and observed without prejudgment, only focusing on what we can see, hear, feel, and imagine.

Before data collection can begin, the research should go through the process of epoché. Through self-reflection, the researcher collects their sense of knowledge about the experience and sets it aside while remaining present in consciousness (Moustakas, 1994). Through self-interviewing, I gathered my responses to the interview questions and documented them in a transcript similar to the interview transcripts (see Appendix G). I reflected on my opinions, perceptions, and assumptions about my experiences with NTLs. Then, I concentrated entirely on what I heard from the participants. Having semi-structured interview questions and allowing free participant responses was another way to ensure my personal experiences with NTLs were not allowed to direct the interview.

Reduction

Following bracketing was the reduction step of the transcendental phenomenological process, also known as transcendental phenomenological reduction, where the focus is concentrated on the experience, not an object. It is a matter of the researcher having the deliberate intention of opening themself to the phenomenon (Moustakas, 1994). The phenomenon was described during the interview, and a plethora of data were collected, including individuals descriptions of their experiences, thoughts, feelings, ideas, and examples. Transcendental refers to the concept that everything has meaning. The experiences with change as the science faculty transitioned from TLs to NTLs were essential and held meaning.

The reduction process highlighted the qualities of the experience. Moustakas (1994) recommends using a modified version of Van Kaam's (1959) analysis method. With it, the researcher individually examines each experience for intersubjectivity and usefulness, combining the experiences into whole phenomena (Moustakas, 1994). I isolated the pertinent data by separating the experiences, examining commonalities, and removing irrelevant statements. Using pre-reflection, reflection, and reduction, the process aimed to explicate the phenomenon's essential essences (Husserl, 1931). During the data review, I meditated to clear my mind and set aside biases, prejudgments, and bracketed to experience an authentic encounter.

Imaginative Variation

The last step was the imaginative variation that explores the experience's environment. By exploring the possible structural meaning that underlies the textural meaning, the research should identify underlying themes for the phenomenon's emergence (Moustakas, 1994). The structural information from imaginative variation is combined with the textural information from the reduction. Following this integration, I identified a "textural-structural synthesis of meanings and essences of the phenomenon or experience being investigated" (Moustakas, 1994, p. 36). Specifics on the application of each of these steps to the three forms of data in this study is further discussed in the following section.

Data Collection Plan

Data was collected through individual interviews, personal items, and a focus group discussion forum. Participants were selected from the interest questionnaire (see Appendix D) and were asked to schedule their interview using Outlook Calendars. All participants participated in an individual interview where the individual interview questions (see Appendix H) were addressed. Participants were also asked to send an example of an NTL they have transitioned

from a TL to an NTL before the interview (see Appendix I for NTL summary with notations); any NTL format was accepted. Interviews were conducted with each participant (see Appendix J for sample transcript). Following the interviews, an online discussion forum was opened (see Appendix K for example, discussion transcript excerpt), and some participants responded to several questions and other participants. Several forms of data are encouraged in qualitative research to promote total immersion into the previous experience (Creswell & Poth, 2018).

Personal Item Analysis

Any document that contains text can be used in document analysis in qualitative research (Patton, 2015). Participants in the current study were asked to submit in advance one example of an NTL they previously transitioned from a TL (see Appendix I for notations from an NTL example). The NTL examples in the current study contain data developed beforehand, without the researcher's intervention, so documents were examined to gain a broader understanding of the phenomenon (Bowen, 2009). The interviews served as the primary form of data; however, qualitative studies collect other data records to support and enhance the interview responses (Creswell & Poth, 2018). The participants were asked to explain the process of transitioning the NTL from a TL as part of the interview. This allowed participants to give a visual representation of their experience. The documents underwent separate analyses using the reflexive approach (Braun et al., 2022; Morgan, 2022). Pre-existing data can be used to develop questions that need to be asked and situations that can be discussed during the research (Bowen, 2009) and used for triangulation and increasing trustworthiness (Morgan, 2022; Patton, 2015).

Thematic analysis, precisely the reflexive approach, was used to analyze the documents before the interviews because this method views the researcher's subjectivity as a resource rather than a problem (Braun et al., 2022; Morgan, 2022). The information obtained from the document

analysis provided historical roots that indicated the conditions impinge on the current study's phenomena (Bowen, 2009). Before beginning the analysis, I first practiced epoché through mindfulness, focusing on the participant's document only. A copy of the specific NTL is not included in the research because of copyright privileges, but an example summary of the process is included in Appendix I. To begin the process, I read through the NTL to understand the concepts and learning objectives. Next, I read through the lab again, focusing on the method I believed the participant would have gone through while transitioning the lab, noting questions I had as I read each section (see Appendix I). These questions were not necessarily all asked during the interview, but several were answered as the participants explained their NTL and what process they went through to transition it. Following my reflection on the lab, I coded the NTL examples (Morgan, 2022). With the reflexive approach, the code evolves as the researcher's interpretation of the data progresses; therefore, the code cannot be determined before the analysis begins. Through the analysis of the ten examples, a code was developed (see Appendix L). Although the focus was on an object in this step, the phenomenological reduction was used to focus on the transition that would have occurred to provide this laboratory as a virtual option. This coding allows the researcher to discover meanings rather than summarize the data (Morgan, 2022). The complete coding process leads to themes of shared meaning (Braun et al., 2022). The code from the document analysis was expanded on during the interview process and the complete code is in Appendix M.

Although coding evolved as the documents were analyzed using the reflexive approach (Morgan, 2022), certain steps were followed throughout the process. Imaginative variation was exercised through examining each NTL example for authenticity, credibility, and representativeness. The examples were transitioned from a previous TL by the participant and an

authentic, credible, and proper representation of the current study.

Individual Interviews

Interviews are an interaction, a relationship, between the participant and the researcher, where the research skills and experience can affect the quality of responses (Patton, 2015). The phenomenological interview is an informal interaction where the researcher asks open-ended questions to participants and allows for comprehensive accounts of the participants' experiences (Moustakas, 1994). Interviews were the appropriate choice for the current study to allow for a relationship between the participant and the researcher to develop to evoke a comprehensive account of the participants' experiences. Participants were asked to review the interview questions (see Appendix H) in advance, so they would have time to prepare rich responses that best described their experiences.

Participants were sent an invitation to the Teams meeting via the Microsoft Teams scheduling application. Participants were reminded of the interview two days before with an email (see Appendix N) and provided a second copy of the interview questions (see Appendix H). All interviews took place virtually via Teams. Interviews followed a semi-structured format using the pre-formulated questions listed below. The Teams meeting was recorded via the Teams recording feature, and transcription was populated via the Teams transcriber feature. The camera was on if the participant requested a video-enabled meeting and off if they requested an audio-only meeting. A second audio-only recording device manually recorded an audio-only copy of the interview as a backup to the video recording. The participants were allowed ample time to answer questions and fully assert their descriptions of their experiences.

Pilot Interview

There is a lack of research on faculty perceptions of NTLs; therefore, original interview

questions were developed. A pilot interview was completed to refine and develop the interview questions (Creswell & Poth, 2018). A pilot study ensured the validity of the interview questions and included one biology faculty member from the candidate's organization. The interview took place virtually, as described in the settings section. The pilot interview was conducted strictly as the data collection methods described in the previous section. No significant changes needed to be made to the interview questions following the pilot study, so no additional pilot study efforts were required. Pilot study data were not used for data analysis.

Individual Interview Questions

1. Please introduce yourself to me as if we had just met one another. CRQ
2. Please walk me through an overview of your career. CRQ
3. Please tell me about your experiences with laboratories as a student, for example, while earning your degrees. CRQ
4. Please walk me through a timeline of your experiences with traditional laboratories. CRQ
5. How do you currently use non-traditional laboratories? SQ3
6. Please only include experiences before the COVID-19 pandemic for the next two questions. Please spend as much time as necessary on these questions, as they are the essence of the interview. What led you to transition from using traditional laboratories to non-traditional laboratories? SQ1
7. Please share your experience transitioning from traditional laboratories to non-traditional laboratories. SQ2
8. Please walk me through the example of a non-traditional lab you shared with me as if I was an observer during the time you used the lab. CRQ & SQ2

9. What aspects of the sample lab were challenging to transfer to a non-traditional format? SQ2 & SQ3
10. How did you use non-traditional labs during the COVID-19 pandemic? SQ3
11. How do you think you will use non-traditional laboratories in the future? SQ3
12. We have covered much ground in our conversation, and I so appreciate the time you've given to this. One final question … What else would you think would be essential for me to know about your experience transitioning from traditional laboratories to non-traditional laboratories? CRQ

Questions 1 through 4 are knowledge questions establishing a timeline with the participants. They were designed as follow-up questions to the participant questionnaire. These questions were intended to be relatively straightforward and non-threatening. They helped develop rapport between the participant and me (Creswell & Poth, 2018). The questions were adjusted as necessary for each participant based on the data included in each timeline.

Question 5 was designed to turn participants' attention to the phenomenon, the transition from TLs to NTLs. Patton (2015) suggested that sequencing questions begin with addressing the present tense of the phenomenon before asking any questions about the past or future. I asked faculty about their current involvement with NTL to ground them in the phenomenon of NTLs before moving on to more in-depth questions.

Questions 6 and 7 allowed participants to reflect on their experiences transitioning from TLs to NTLs. This allowed me to experience firsthand the connection between the participants and the phenomenon (Moustakas, 1994). Probing questions encouraged participants to elaborate when needed. Most of the interview was spent on this question and the entire experience.

Questions 8 and 9 addressed the example NTL provided by the participants. Allowing participants to play a role in the research beyond the interview helped create a more collaborative research process between the participant and the researcher (Patton, 2015). These questions also helped triangulate the themes during data analysis because they asked the presenter to explain the experience resulting from the phenomenon.

Question 10 explicitly addressed the effects of the COVID-19 pandemic on the faculty's experience with NTLs. Barton (2020) found that most faculty reflected negatively on the transition of field exercises into alternative forms during the universities' closings; however, it was necessary for the study to separate the experiences during the pandemic from the experiences before the pandemic. The pandemic causes unprepared faculty to transition to online learning in a rush and without proper training (Cutri & Mena, 2020). This question allowed me to examine the timeline of the experience and determine the role of the pandemic in the textual description of the experience.

Question 11 was designed to allow the participant to use their experience and look toward the future as to how they would assist a colleague through the phenomenon. Through Questions 6 through 10, the participant was given a chance to fully explain the phenomenon from start to finish and reflect on the future. A baseline was established with the present tense and past questions, and Patton (2015) suggests asking questions about the future last. Question 12 was structured to have the participant think back through the interview and include experiences or comments that they felt were missed through questioning and include them here.

Individual Interview Data Analysis Plan

After each of the interviews was completed, a complete transcription of the interview was transcribed using the transcription feature within Teams. The video, audio, and transcriptions

were saved only under participant pseudonyms. I reviewed the interviews and edited the transcripts auto-populated (see Appendix J). I analyzed interview data using the transcendental phenomenological approach outlined by Moustakas (1994). Before beginning the analysis, I practiced the same epoché through mindfulness mediating that was exercised during the document analysis.

First, the responses were organized. Next, I listed the relevant expressions. Then, through phenomenological reduction and elimination, I removed phrases that would not be part of the invariant constituents and formed textural descriptions of the experiences (Moustakas, 1994). During this process, I kept a reflection journal and made entries several times a week (see Appendix O for a sample journal entry). The reflection journal allowed me to separate my expectations and assumptions from the data under analysis. Continuing, I considered each participant's statements for the significance of describing the experiences. I recorded all relevant statements. Finally, using imaginative variation, I developed structural descriptions of the experience. I validated the invariant constituents with the participants by emailing them the sample description (see Appendix P for sample description) for their interview and having them reply with any corrections.

Focus Group Forum

At the end of the interview, the participant was advised of the focus group forum that took place following the conclusion of the individual interviews. All participants were sent an email invitation to the discussion forum (see Appendix Q) and provided instructions to access the discussion forum platform. The focus group allowed interaction between participants and further emergence of shared experiences. Focus groups allow for a large-scale second interaction with multiple participants during the same window of time (Patton, 2015). Furthermore, focus groups

allow participant interaction and provide a check and balance that weeds out false views and narrows in on the truth. In the current study, all willing participants were invited to join the discussion forum to interact with other participants. The focus group sample size was based on participants' willingness and attendance at the focus group forum. Six participants chose to participate in the discussion forum by making posts. The focus group forum prompt reflected the interview questions and confirmed themes and the emergence of new themes. The focus group forum was transcribed (see Appendix K for a sample excerpt with notations) and included in the data analysis.

Focus Group Forum Prompts

1. Please summarize your general experiences with traditional and non-traditional laboratories for the group. CRQ & SQ2
2. Please provide a brief timeline of your experiences transitioning from traditional laboratories to non-traditional laboratories. CRQ & SQ2
3. How do you use non-traditional laboratories currently? SQ3

Focus Group Forum Data Analysis Plan

I saved the text from the discussion board into a file. Participants were only allowed to name themselves in the discussion board registration process, so no actual names were included in the file. Again, I practiced Epoché through mindfulness meditation and cleared any preconceived opinions I may have developed through the research process. The data was processed as the individual's interview data, and no new themes were evident. Participants only posted once each, and only one reply was made to a participant's post. I could, however, see that the participants were viewing the others' posts by the view count. Overlaps, validity, and contradictions to the themes established in the individual interviews were noted (see Appendix K

for a sample excerpt with notations).

Data Synthesis

Data analysis from the documents, individual interviews, and focus group discussion forums were compared and combined to identify the study's themes. Once themes had been identified, I developed and assessed the interpretations and validated the invariant constituents with the participants. The textual descriptions from the phenomenological reduction and the structural descriptions from the imaginative variation were fully synthesized to form composite descriptions of the experience of the science faculty as they transitioned from TLs to NTLs.

Transcendental Phenomenological Reduction

Data were listed by significant statements as part of the transcendental-phenomenological reduction step. Data included individuals' experience descriptions, including thoughts, feelings, ideas, and examples (Moustakas, 1994). Moustakas recommended modifying van Kaam's analysis method. I examined each experience for intersubjectivity and usefulness and combined the experiences into a whole phenomenon(s). Because I share the experience with participants, the modified Stevick-Colaizzi-Keen's method is most fitting. Reduction was accomplished by separating the experiences, examining for commonalities, and removing irrelevant statements. The last step is the imaginative variation that explores the experience's environment. The structural information from step three was combined with the textural information from step two. Following this integration, I saw a "textural-structural synthesis of meanings and essences of the phenomenon or experience being investigated" (Moustakas, 1994, p. 36).

Horizontalization

A portion of phenomenological reduction is a process called horizontalization (Moustakas, 1994). Once the significant statements were separated, I read through them a second

time and coded them. Horizons are unlimited, so the process of horizontalization is looking at the data multiple times and examining for new themes. Each time I looked at the statements, I sought a new blank mindset through mediation, then searched for new themes that may have been missed during the previous analysis.

Imaginative Variation

The following analysis step is the imaginative variation, where the researcher's imagination was used to develop a structural description of the phenomenon (Moustakas, 1994). This included the "utilization of imagination, varying the frames of reference, employing polarities and reversals, and approaching the phenomenon from divergent perspectives" (Moustakas, 1994, p. 97). Moustakas explained that imaginative variation is *how* the experience gave way to the *what* of the experience.

Synthesis of Meanings and Essences

Using the textural and structural descriptions derived from the previous steps, I next developed unified statements of the essence of the experience (Moustakas, 1994). That is, I concluded the conditions of the phenomenon. The essence of the experience was continuous, though the essence of a phenomenological study was tied to the time and researcher of the study.

Trustworthiness

Trustworthiness was established through credibility, dependability, transferability, and confirmability (Cresswell & Poth, 2018). Dependability and confirmability occurred as the researcher audited the research process. Wolcott (1990) does not use traditional validation means and rejects the concept that it is critical for understanding. However, Lincoln and Guba (1985) argued that member checking is the most effective approach for establishing creditability.

Credibility

Credibility was established through member-checking, alternative explanation analysis, and triangulation. Credibility was established through validation with the participants through member checking individual descriptions (Harper & Cole, 2012). Member checking took place after data had been analyzed to the point of their individual description formed (see Appendix O). The participants reviewed the individual descriptions (Moustakas, 1994). They did not request to adjust the outcomes to reflect their perceptions better or remove them from the study. Only the explicit and compatible expressions were kept. The participants were asked to review drafts of the work and offer their insight into the observations, language, and interpretations (Creswell & Poth, 2018).

Credibility was also established by inductively and logically analyzing the data for alternative explanations (Patton, 2015). Inductive analysis, including organizing the information to lead to alternate possibilities, and logical analysis means I logically considered other possibilities and examined if those possibilities can be supported by the study's data. Lastly, credibility was established with the triangulation of the emergent themes of each participant. Triangulation of data means checking and rechecking the consistency of responses from the participants derived during the different data collection methods. The interview data was compared to the sample NTLs submitted and responses regarding the NTL. This data was then be compared to the responses within the focus group interview.

Transferability

Transferability shows that the findings of the study can be applied to another context (Lincoln & Guba, 1985). Transferability was examined between the thick descriptive themes identified by each participant. The findings in the current study could apply to other institutions

not included. If alignment was found between the participants' experiences, then transferability in the current study could be inferred. The current study recruited participants from one institution; however, participants referred to their experiences with previous employers in their interviews. The participants' experiences aligned with each other and extended to institutions not included in the recruitment.

Dependability

Dependability in qualitative research means that the procedures have been reviewed and are appropriate for the study (Creswell & Poth, 2018). The course structure of the dissertation process ensures that multiple faculty members have reviewed the study and provided feedback on the structure. The dissertation process is designed to build through multiple courses, allowing graduate education faculty multiple opportunities to analyze the dissertation in many steps. In addition to the multiple courses, the study received IRB approval before data collection began.

Confirmability

Confirmability was established by having the participants review the descriptions, ensuring that the data identify their experiences correctly (Moustakas, 1994). Information was shared via email, and participants were allowed to review the analysis. If they feel their experience has been misconstrued, I would have worked with the participant to correct the issue, although no participant felt it was needed. The participant could have chosen to have their data deleted from the study. I had preconceived notion of the experiences of the participants; therefore, data analysis remained free of bias, motivations, or personal interest.

Ethical Consideration

An IRB formally designated by each institution must review a research proposal before data collection begins. IRB approval was received from Liberty University and the participating

university (see Appendices A and B). This ensured appropriate steps were taken to protect the rights and welfare of research participants. Each participant signed a written informed consent letter (see Appendix F). Participants were informed that their participation was voluntary. The study was conducted with respect for gender, religion, culture, and other differences.

All participants were adults, and the information discussed during the interview was not sensitive. However, the data could negatively reflect the participants if their opinion is unfavorable to their employers. Therefore, each participant or institution was assigned a pseudonym, and the transcriptions were stored on a USB in a locked filing cabinet of the candidate's office. All transcription-associated files were saved under the pseudonym only. In the focus group forum, all participants were registered using their pseudonyms to protect their identity. They were asked to use the pseudonym for their institutions as well when on the discussion forum board.

Summary

Using a transcendental phenomenological qualitative design allowed a thorough investigation of biology faculty experiences with change as they transitioned from using TLs to NTLs. The research questions aimed to thoroughly explore the experience of change experienced by science faculty members. The university was selected based on its course offerings and online science programs, providing a diverse pool of possible participants. Participants were purposely selected based on their experience with NTLs. My positionality, including interpretive framework, philosophical assumptions, and researcher's role, explained my preexisting experiences that need to be considered within the current study. The procedures included the required permissions, recruitment, data collection plan for interviews, personal items, and the focus group. Data collections were analyzed for emergent themes from the experiences.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study was to describe faculty's experience with change as they transition from using TLs to using NTLs at postsecondary institutions. This chapter presents the findings from the data analysis collected through the three data collections during this study. It begins with a presentation of the study participants. It then moves into sharing the found themes of experience with change during the faculty's transition from using TLs to NTLs. The chapter concludes by addressing the study's research questions.

Participants

This study included science faculty with at least one year of experience teaching online science courses that use NTLs. Participation was open to any qualified faculty, and participants were asked to refer faculty they felt would be eligible and interested in the study. Recruitment was targeted at the USNU faculty because of their large pool of science adjunct faculty and because USNU offers several online science courses with NTLs. Adjunct faculty typically have experiences beyond their part-time employment; therefore, a more diverse range of experiences was recruited using the adjunct pool at USNU. The intent was to identify a heterogeneous group of 10–15 faculty members through direct contact and referrals. Eight participants were affiliated with USNU, and two were referrals from other participants and not affiliated with USNU. Diversity in years of experience, sex, and age was achieved, but diversity in participant race was not. Out of the 16 respondents to the survey for qualification, only two were of minority populations. Of those two, one chose to move forward and participated in the study, and the other did not respond to schedule their interview. Table 1, Figure 1, Figure 2, and individual descriptions below offer more detailed information about the study participants. All faculty

members submitted a demographic survey for qualification purposes, a personal example of NTLs they had used in the past and participated in the interviews; however, only six participants responded on the focus group discussion board.

Table 1

Science Faculty Participants

Teacher Participant	Years Taught NTL	Highest Degree Earned/Year	Content Area	Age Range
Tasha[a]	4	Masters/2010	Biology & Chemistry	45–54
Roger	13	Doctorate/1997	Biology	55–64
Martha[a]	9	Doctorate/2005	Chemistry	45–54
James[a]	7	Doctorate/2004	Forestry	45–54
Jessica[a]	10	Doctorate/2022	Chemistry	35–44
Laura	2	Masters/2018	Biology	35–44
Jo[a]	6	Doctorate/2014	Biology	25–34
Rich[a]	13	Doctorate/2000	Physics	55–64
Karen[a]	8	Doctorate/2008	Biology	45–54
William[a]	4	Masters/2005	Biology	35–45

Note. Participants in this study were not limited to experiences with USNU but were able to discuss experiences at any institution in their career history.

[a] Participants who discussed transitions at institutions other than USNU.

Figure 1

Science Faculty Participation by Experience

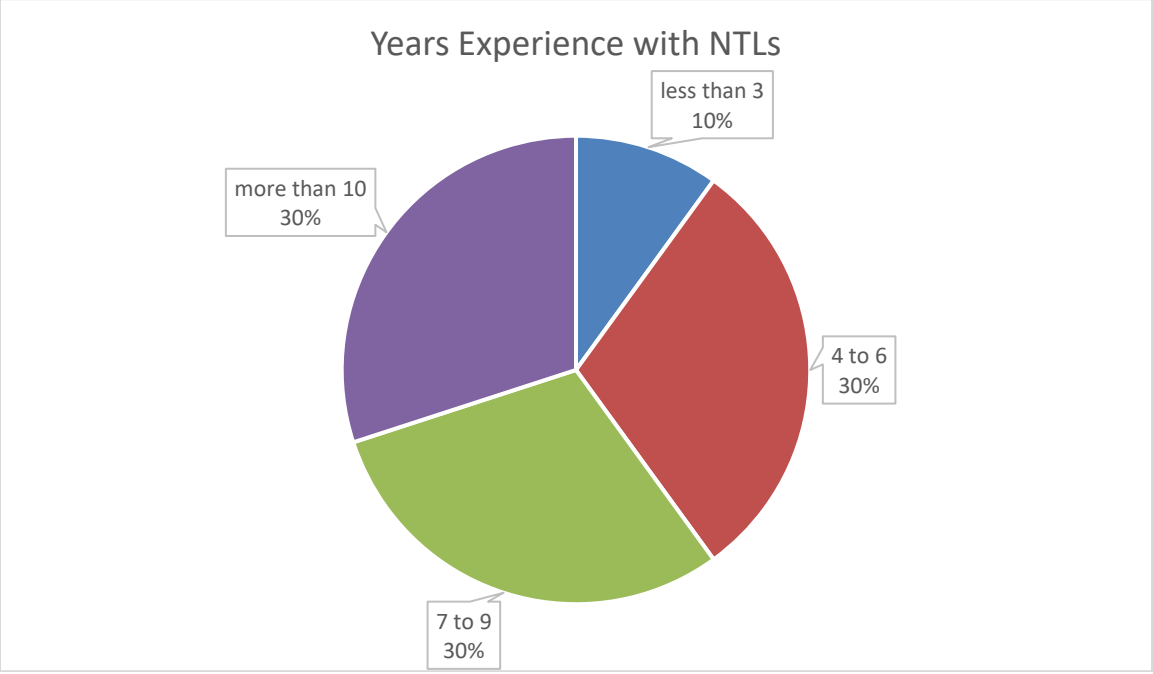
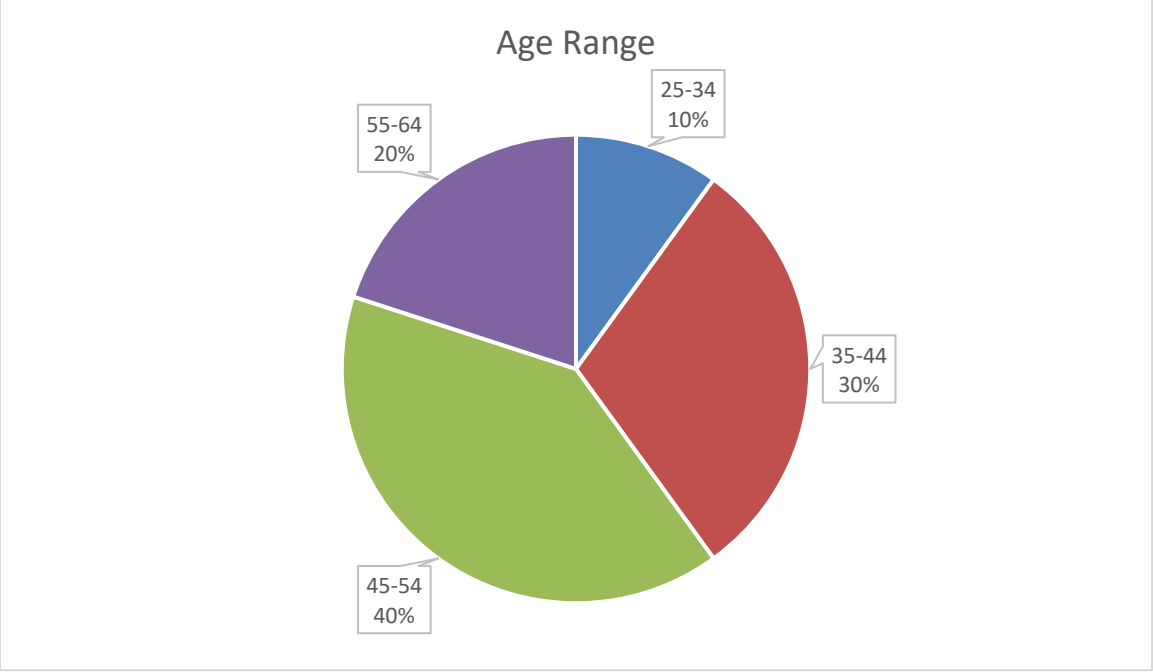


Figure 2

Science Faculty Participation by Age



Roger

Roger is a White male in the age range 55–64 with a BS in Biology (1985), MS in Biology (1989), and PhD in Biology (1997). He has taught TLs throughout his career and began teaching NTLs with online Biology courses in 2010 when he was hired as an adjunct at USNU. Roger teaches in person as his full-time faculty position and has taught online using NTLs as an adjunct at several institutions, including USNU.

Tasha

Tasha is a multiethnicity female in the age range 45–54 with an AA in Biology Education (2002), BS in Unified Science Education, Biology, and Chemistry (2004), and MS in Science Education, Biology, and Chemistry (2010). She has a wide range of experience teaching high school and at the college level, both in person using TLs and online, using NTLs. She began teaching online in 2019 due to the pandemic and continues teaching online post-pandemic. Tasha was referred as a possible participant through professional contacts and not affiliated with the site. Tasha's experience with NTLs was mostly in Chemistry courses.

Martha

Martha is a White female in the age range 45–54 with a BS in Biology (1992), MS in Biochemistry (1995), and PhD in Chemistry (2005). Martha has experience with high school science education as well as post-secondary. Martha began her career teaching traditional courses and labs and started teaching online with NTLs in 2014 in a previous faculty position in Chemistry courses. She previously taught full-time online and now teaches in person at a local high school but has maintained her position as an adjunct online with USNU.

James

James is a White male in the age range of 45–54 with a BS (1993), MS (1998), and PhD (2004). James taught traditional courses with TLs at the start of his career. However, in a previous position, he was hired to transition courses online that included field work. He started teaching environmental science online using NTLs in 2007 and utilized field labs remotely. James teaches in person in his full-time post-secondary faculty position but has continued teaching online in environmental science at USNU.

Jessica

Jessica is a White female in the age range 35–44 with a BS in Chemistry (2006), MS in Chemistry (2009), and EdD in Learning and Organizational Change (2022). Jessica has experience in post-secondary chemistry education and high school education. She was teaching traditional courses with TLs when asked to transition courses online by a previous employer. Jessica began teaching Chemistry online using NTLs in 2013. She currently teaches high school chemistry and has continued teaching online with USNU.

Laura

Laura is a White female in the age range 35–44 with a BS in Biology (2006) and an MS in Biology (2014). All of Laura's experience is as an adjunct at several institutions over the years, and she has taught online for the past two years with USNU. Laura began teaching traditional courses with TLs and transition to teaching online when hired by USNU. She teaches various biology courses in person at two institutions and online with USNU.

Jo

Jo is a White female in the age range 25–34 with a BS (2010) and a Ph.D. (2014) in Biology. Jo started her teaching career face-to-face with TLs but began teaching online in 2017

with her current post-secondary institution. She was then hired by USNU in 2018 to teach online using NTLs. She teaches varied biology courses in person and online at both institutions.

Rich

Rich is a White male in the age range 55–64 with a BS (1994), MS (1996), and PhD (2000) in Physics. Rich is tenured in a full-time position where he teaches physics face-to-face. He began teaching physics online as an adjunct at several other institutions in 2010. Rich was referred as a possible participant through another participant and not affiliated with the site.

Karen

Karen is a White female in the age range of 45–54 with a BS (2001) and a PhD (2010) in Biology. Karen has experience teaching in person and online at several institutions, including USNU, starting in 2015. Karen's teaching career began with traditional courses and TLs, and her first online teaching experience was when she was hired as an adjunct with a current employer. Karen teaches Biology full-time in person and online as an adjunct.

William

William is a White male in the age range of 35–44 with a BS and MS in Biology. William began teaching online in 2019 after finishing his graduate degree. William has taught at the post-secondary level for four years as an adjunct at two institutions, including USNU. William began teaching in person as an adjunct using TLs and then transitioned to teaching online with his current employers.

Results

The data collected from science faculty participants through personal examples of NTLs used, interviews, and a focus group discussion board were analyzed and organized into themes and subthemes. Table 2 below identifies the themes and subthemes identified during data

analysis. The type of lab each faculty member transitioned to (online, remote, or lab kits) did not affect the faculty member's experience, as there were no unifying themes identified between those who transitioned into using the same form of NTL.

Table 2

Themes & Subthemes

Theme	Subtheme 1	Subtheme 2	Subtheme 3
Support during transition	Teamwork	Guiding measures	Training
Effects of infrastructure of transition	Initiation	Course preparation	Available software for labs
Faculty's change in role during the transition	Facilitator instead of teacher	Less control	Effectiveness of NLTs for learning
Faculty's embracement change	Teaching at multiple institutions at the same time	Transitioning positions	

Support During Transition

The first theme identified in this study is the importance of support during the transition from face-to-face teaching to online teaching using NTLs. Support was defined as something or someone besides the participant that aided in the transition from TLs to NTLs. It was clear in almost all interviews that even when the participant was working alone to transition the course to using NTLS, all but one were provided some support. Support included several components for participants and was mentioned in nine interviews and four discussion posts. Support occurred through people, documents, and planned training. Support is divided into three subthemes: teamwork, guiding measures, and training.

Teamwork

The first subtheme of support was teamwork. Codes such as group effort, teams, coteaching, instructional designers, leadership, and supporting staff were used to identify this subtheme where the support was from another person. Having a group of colleagues work together to transition courses online decreases the workload for the faculty member and allows the collaboration of ideas and planning. During her interview, Jo stated:

> I had never used the type of lab software we were using, but my colleague that I was working with had, but she had never used the LMS, and I had. So, we just kind of taught each other the systems and made it work.

Jo noted that even though she had never used that specific lab software, she felt she could have figured it out regardless, but it was helpful having someone who had used it before guide the way. During his interview, Rich explained he also felt that having someone with experience was useful when first using the online software and lab kits. When referring to the virtual NTL sample, he said that it was his first time using that website and that his colleague was able to show him how it worked. Again, referring to the sample NTL during the interview, Rich said he has taught that lab face-to-face many times, but teaching it virtually was different, so he was glad he had someone to help.

Several participants mentioned the inclusion of instructional designers in their transitioning of courses to online formats. Jessica said at one institution, “They had an actual department of instructional designers to help us build our classes and put them online.” Karen also mentioned an instructional designer that was part of the department when she first started teaching online and said that they reviewed materials like her sample NTL before they were put into the course. Similarly, James was onboarded with an instructional designer he would work

with while transitioning to a program with online fieldwork. James stated, “So that was my first introduction to instructional technology and instructional design … someone who had a few years of experience developing some online content in the early days.” James explained that the instructional designer was critical to the program’s success, fulfilling the competencies required and utilizing the technology. James stated on the discussion board, “some of the technology I had never used before … so her support was critical to the transition.”

Other participants mentioned that leadership was an essential piece of the transition. Roger said his transition was good but felt it would “depend on who’s running the department or division.” Laura’s experience was limited to only teaching as an adjunct. Still, she said that having experienced faculty as mentors was critical in her learning process and starting her teaching career. Laura and Jo also mentioned having supportive colleagues on the group discussion forum. On the discussion forum, Laura said, “I never felt like I had to figure stuff out myself, there was always someone I could go to for help.” Also on the discussion board, Jo and William both mentioned they had a colleague share course materials with them when they first began teaching an online course, and it was constructive getting started.

Guiding Measures

The second subtheme of support was guiding measures. Guiding measures were defined as something provided to the participant to aid them with the transition from TL to NTL. Codes such as rubrics, assessments, and learning outcomes were grouped together as guiding measures. When initially transitioning a science course to an online platform and using NTLs, guiding rubrics were often provided and found helpful in ensuring that appropriate outcomes were achieved in the online platform courses. Jessica stated, “When we were transitioning all of our material to online, we had to meet the quality matters rubric … every school I have worked with

kind of referenced the quality matters at some point in time." The instructional designer that James worked with was responsible for ensuring the courses met all the course competencies. Rich focused on providing the learning outcomes associated with his sample NTL, which were the same as the TL offered on campus. He referred to the NTL sample: "The students are getting the same learning outcomes in both formats; I made sure of that."

Jo said there are learning outcomes for each class she teaches and that students in both formats take the same course assessment, so it was a built-in way to ensure the online students were getting the same content as the face-to-face. Rich mentioned that he felt better guidelines for measuring course outcomes that were used everywhere and not just at one institution were needed. He said, "Just because you think you're doing a great job doesn't mean your student will measure up against another when they get into graduate school." None of the participants mentioned knowing any guidelines for courses at USNU.

Three participants mentioned the use of course evaluations as a tool for their institution to see if they are meeting faculty expectations in the online courses that use NTLs. Laura said she was frequently evaluated but suggested it may be because she is an adjunct. The NTL example she shared was designed by USNU, but she included excerpts where she had created additional resources for the students to use in the lab. These were appreciated during one of her evaluations. She said: "I like to make screen capture videos of how to operate some of the tricky parts of the lab so that the students don't waste time on the technology." William and James said on the discussion forum that they occasionally get emails if they have missed entering a grade but did not refer to evaluations.

Training

The third subtheme of support during the transition was training. Training was defined as formal scheduled training organized by the institution before the participant began teaching online for that institution. The amount of training each participant received before or during the transition varied significantly between institutions. James, Jessica, Tasha, William, Karen, and Mary received no training before transitioning their courses online with employers other than USNU. William said, “I was trained in my content, but no one taught me how to teach, and no one taught me how to be effective online. It was just, you know, here’s what you need to do, and I did it.” However, all participants affiliated with USNU received a month-long training after being hired as an adjunct at USNU. However, for many who were already teaching online, this training was after their initial transition. Laura’s experience teaching an online science course was limited to USNU, and therefore, she received a month-long training before she began teaching online, but she felt she did not learn anything new as far as online platforms because she already used them within courses she was teaching face to face. She said, “I already knew about eScience and their interactive labs because we use a couple of them during down weeks on campus, so I was just really learning how USNU used these labs.”

Effects of Infrastructure of Transition

The second theme identified in the study was how the effects of the infrastructure impacted the transition for the participant. Infrastructure was defined as the elements in the institution that were in place before the transition began. All participants discussed certain parameters that effected their transition. These things were outside the participants control and were not people, so they were grouped together as infrastructure. The effects of infrastructure

theme is divided into three subthemes: the initiation of the transition, the course preparation, and the available lab software.

Initiation

The first subtheme of the effects of infrastructure on the transition theme was the initiation. Initiation was defined as who or what initiated the participant's transition from teaching TLs to NTLs. The initiation for the transition was mentioned in all interviews and varied significantly. Several institutions asked or mandated that specific courses be moved to an online platform in response to the growing online learning needs. Other participants were the ones who initiated the transition by gaining approval from their department or by obtaining new employment. The initiative to move science courses online and use NTLs was either driven by the institution to increase online course options or by the faculty member for personal reasons.

Jessica's first transition to NTLs was "at the institution's demand to offer more online accessibility." However, her goal with the NTLs was to "keep the students being hands-on." James' employing institution received grants to move natural resource courses to an online format. He said, "We received this grant from the Department of Labor to turn this natural resources curriculum you know from traditional brick and mortar and make it an online degree program." On the other hand, Martha was more personally motivated to transition to teaching online to decrease her commute. Tasha was also encouraged to transition to a remote position to care for a family member. Laura, Rich, and Jo all mentioned they started teaching online to increase their incomes. Of the half of the participants that were directed by the institution to transition their courses online, none of them communicated any animosity towards to the directors. Initiation was mentioned in all the interviews, but it was not found to negative or positively impact the transition.

Course Preparation

The second subtheme of the effects of infrastructure on the transition theme was course preparation. Course preparation varied between courses that were pre-developed by the institution and courses that were developed from scratch by the participant. Codes such as course shell, course writing, and course development were grouped into the subtheme of course preparation. This affected the transitions in a couple of ways. At USNU, the course was prepared for the participants including the NTL. However, several of the participants had started teaching with NTLs before they were hired by USNU, so this would not have been their initial transition. Six participants discussed the transition at more than one institution which included different course preparations. This breadth of experience spoke to the effect the course preparation had on those six participants since they had experienced two different transitions with two different course preparations.

The six participants who discussed teaching courses with NTLs they created from scratch all agreed that the second time teaching the course was much less work. After the initial transition of moving the material online, there was less work to set up and monitor labs in the NTLs. Rich said he had no idea how to set up anything online before being asked to teach an online course, so he started with only the basics and added to it over the years. He said, “It might have been easier if the same platforms were available back then.” Roger said, “I think what makes it easier is not having to set up a lab, not having to again mess with chemicals or getting dyes all over you.” Jo mentioned that lab prep with her face-to-face courses could take hours to set up and teach, but there wasn’t much to grade. She said, “In the face-to-face classes, if they are there, they get the credit, and then the material is on a future exam; in the online course, there is no set-up, but then you have a lot more grading.”

Course preparations correlated with training. In the transitions where the course was already created by the institution, there was training that was required for the participant. Four participants share that this did positively help them in their transition. Karen said, “When I was creating everything myself, I was just figuring it out. At USNU everything was done and ready, and it just up to me to go through training and then learn to grade their assignments.” Roger submitted an NTL from USNU and said, “I did not write this lab, so that was easy, I just had to learn how to instruct them to use it, and then learn how to grade it.”

Available Lab Software

The third subtheme of the effects of infrastructure on the transition theme was the availability of lab software. Lab software was defined as a website or provider of a prepared lab that could be used as an NTL. There were several examples found during the literature review such as Labster and Science Interactive. Codes such as online lab access and virtual simulations were grouped as lab software in the subtheme. Having access to lab software was mentioned by four participants who were designing their own courses, and it was used by several others who started teaching prepared courses with NTLs. Five participants mentioned the availability and affordability of lab software as limiting factors when designing their courses for the online platform. Rich uses an online lab software in one course he teaches outside of USNU that requires students to purchase a separate access code. He said, “If the student doesn’t buy the access code, they just get zeros for the lab, and they fail. It is not like when you can’t afford a book, and you can still chip your way through the material.” Differently, Jessica transitioned to an instrumental analysis class online during the pandemic and felt it was different than transitioning the courses she had done in 2010 because of access to free software. Before, Jessica did not have access to the same laboratory software she did during the pandemic. She stated, “I

was very fortunate. like I did the best I could, but I was very fortunate in that many of the companies were giving out free software for the duration of the year." She said under different circumstances this software would not have been available because the cost exceeds what students are willing to pay for one semester of course work. Laura has used the same lab simulations at two different institutions, so she was familiar with them and felt confident in the learning outcomes the students would get from the lab, but she was unsure how students felt about the cost. She said, "Those labs are intense, they have to answer the question, and it's not graded as participation; they have to read the pre-lab and answer it correctly. And that's after dropping the money on the software."

Faculty's Change in Role During the Transition

The third theme identified in the study was the change in the faculty's role during the transition. Change in role was defined as a shift in the role the participant played in the NTL versus the TL, a shift in the participant's self-reflection, or a shift in their value of TLs and NTLs during the transition. This was separated from the next theme, the participant's response to change, in that these changes were directly related to or a result of the transition from using TLs to NTLs. Codes such as problem solver, facilitator, no longer a teacher, control, purpose, and value were grouped together into this theme. The current theme was divided into three subthemes: facilitator instead of teacher, less control, and effectiveness of NTLs for learning.

Facilitator Instead of Teacher

The first subtheme of the change in faculty's role during the transition theme was that the faculty felt like a facilitator instead of a teacher. Five participants in the study mentioned that their role as instructor was altered a little when teaching online in a few different ways. Some participants felt they were more of a facilitator or problem solver in the online role than in the

face-to-face courses. When referring to the virtual labs provided through a software website, Jessica stated during the interview and then again on the discussion forum, “I think my role became less of an instructor and more of a troubleshooter, like this isn’t working, why isn’t this working?” She expressed that when something does not work in a face-to-face lab, it’s a learning experience, but when a virtual tool doesn’t work, it’s usually a technical issue, not a chemistry one. She continued, “I spent 40 hours a week sitting behind my computer troubleshooting what was going on,” and “All I can do is give them feedback; I can’t integrate myself in any way.”

Others mentioned that it is harder to connect with students when you are not teaching them the material. When course material is made to where the student asynchronously learns, the role of the professor is no longer a teacher but a facilitator or problem solver; this is especially true of virtual labs provided through lab software. When Rich was discussing the NTL sample during the interview, he mentioned he had to find materials that the student could work with without supervision. He said, “They aren’t in the lab with me, so I can’t supervise, so I am more providing them with the directions and answering questions … so it can’t be something super complex they can’t figure out.” Similarly, Karen mentioned the case studies on the discussion board and said she enjoyed them, “but unless you are responding to everyone, it’s hard to have personally connections with the students in the virtual classroom.” In the discussion forum, she said, “I ask them to submit pictures at the beginning, so I have a face with their name, but it is still hard, you don’t see that picture in an email or post, so you forget who they are.”

Less Control

The second subtheme of the change in faculty’s role during the transition theme was that the faculty felt like they had less control when using NTLs. Less control was defined as when a faculty member felt like certain elements in the exercise or process was not within their control

during the transition. Codes such as less control, no choice, and limited options were grouped together into this subtheme. When using NTLs that have been prepared ahead of time by a software or course shell, faculty felt they had little control over how the lab was conducted and what was presented. Jessica felt that when teaching in person, she could spontaneously let her students suggest ideas for labs, but when teaching online, she could only use the prepared materials. She stated, “They would find a video and ask, can we do this? And I would look it over and be like, yeah, let us do it when we get to this material … so no limitations.” Jessica continued, “I mean, essentially, what we’ve done with some of these virtual labs is taking them entirely away from the instructor’s ability to do anything.”

Similarly, Roger and Rich mentioned that it was challenging to engage with the students in virtual formats and do the labs with them. Laura, Jo, and William said that while they enjoyed teaching online, it was not the same as working with students on campus and seeing them daily; they all felt disconnected from the classroom. William specifically said, “I would like to be able to change things up in the classroom, but in some of these labs, you can’t change anything; you can only select to use it as is.” Differently, Jo commented that some students like the autonomy of not having a faculty member know you personally but were not sure if all felt that way. She said, “Some students won’t reach out to you at all the whole term, and they do fine … others need more support and connect with you … kind of like a classroom.”

Effectiveness of NTLs for Learning

The third subtheme of the change in faculty’s role during the transition theme was the faculty’s value for the effectiveness of NTLs for learning. This subtheme was identified even though the faculty’s opinion of the efficacy of NTLs wasn’t directly asked; it was shared in six interviews. It was placed within the current theme because the faculty’s opinion had changed

during their experience or as a result of it in several cases. Unsurprisingly, the opinions varied greatly from fully accepting NTLs as valuable and equal options to the other extreme of absolutely detesting them. Both extremes were represented by the participants and across all types of NTLs. Martha stated, “I think the lab kits are actually more challenging for students to do because they’re at home and there’s nobody there telling them this is what you do next … you have to problem solve.” Similarly, Roger mentioned that in some anatomy courses, even brick-and-mortar classes use more computer models and fewer bodies. Roger mentioned that he had read some of the research available and that he came to realize that the NTLs seem to work out just fine. He said some professions do not need to practice hands-on dissections because they won’t do it in their field; they need the basic information only, and the end goal is more important. Roger said, “They can still get that same information by doing a virtual lab.” Tasha was the only participant who mentioned disliking teaching online. Still, she also saw the need and value in the course offerings for non-traditional students and had no plans of terminating her online position.

All six participants who shared their opinion on the effectiveness of NTLs expressed that they understood the need for NTL options but had reservations about the experience for the students. Jessica said, “It’s really hard; we’re going all online, and the virtual labs are fun, but are they really grasping the lab element that they need in the course?” Along the same tune, James said, “You can accomplish the same learning outcomes and the same goals, but it doesn’t mean you felt it NTLs was an equal.” Other participants said they knew that online science courses were needed for students who could not take campus courses but were unsure if the experience would measure up.

Faculty's Embracement Change

The fourth and final theme identified in the study was faculty embracement of change. Through the interviews, it became clear that participants had experienced changes closely tied to the transition, although during different times in their careers. This was reduced from the related experiences among participants with teaching at multiple universities and having multiple transitions between institutions during their careers. Although not all experiences with change were directly related to the central research questions of this study, participants' responses to those changes spoke to their overall capability of enduring transitions. This theme was separated from the previous one in that these experiences were strong commonalities between the participants but not directly from the central phenomenon. All participants in the study were teaching at multiple universities simultaneously at the time of the study. Similarly, participants had transitioned between universities varied amounts of times as well. It was evident that the participants in the study were willing to make career transitions and adapt to those changes as needed. The faculty response to change theme was divided into two subthemes: teaching at multiple institutions and transitioning positions.

Teaching at Multiple Institutions

The first subtheme of the faculty's embracement of change theme was that participants were teaching at multiple institutions simultaneously. The reasoning for the multiple positions was not assessed during the study, but it was clear that this was a commonality among the participants. Codes such as the combination of full-time roles and adjunct work were grouped in this subtheme. All participants included in the study were teaching at multiple educational institutions at the time of the survey. Martha and Jessica taught high school chemistry full-time and taught chemistry online at USNU as adjuncts. Similarly, Tasha taught chemistry online for a

high school program and online for a university. Roger, James, Jo, Rich, Karen, and William all teach full-time at different institutions and adjuncts at USNU. Differently, Laura was teaching at three institutions as an adjunct while applying for faculty positions in her local area. She said, “I think I’ll always teach online on the side. You can’t beat the extra income, but I want a full-time position when possible, and I think starting out, you have to get experience face-to-face.”

Participants’ experiences with change when transitioning from TLs to NTLs were not limited to USNU; many participants discussed these transitions at other institutions. This fluidity allowed a broader exploration of this experience not tied to an institution. Some participants had experienced this transition at more than one institution, which broadened the range of experiences even more. Four participants compared their experiences at different institutions. In the discussion post, William said, “Each place has their own path of getting you ready, and it doesn’t matter what level you come in on, you all have the same process so you’re ready.” It became clear that participants in the study did not avoid new experiences or transitions.

Transitioning Positions

The second subtheme within the theme of participants' embracement of change was that the participants all seemed to have transitioned from one position to another at least once, but more commonly, multiple times throughout their careers. This second subtheme was derived from codes such as previous institutions and institutional names other than USNU. The two subthemes of faculty’s response to change were connected in that participants seemed to welcome new situations that required them to make significant professional transitions.

None of the 10 participants started at the same institution where they were teaching at the time of the study. Jessica stated, “I feel like if you stay at one play too long, you get stale.” Although not all participants mentioned intentionally transitioning to increase their teaching

skills, it was clear that transitioning between institutions was common. Differently, Laura said she felt a bit nomadic but that until she landed something permanent, she enjoyed the flexibility of short-term contracts with the adjunct positions. She noted that repeating courses can get boring but did get easier with time. She stated, “When you’ve graded the same assignment 100 times, you have exactly what you are looking for, and it goes quickly; you can also keep feedback ready in a document, and it’s a huge time saver.” Rich had earned tenure in his full-time role before he was asked to teach some online courses and joked that he may have said no if it would have been the other way around. However, after teaching online for several years, he felt it was good to “get out there and see what other people are doing.” Whether embracing change was related to the discipline or the participant’s willingness to participate in the study was unclear, or if all faculty felt the same way.

Research Question Responses

This study was designed to address a central research question examining the experiences with change of science faculty transitioning from teaching TLs to NTLs. In this section, direct answers to the central research question and the sub-questions will be provided based on the findings of this study. Further analysis of the findings is discussed further in Chapter 5.

Central Research Question

What are the shared lived experiences of science faculty transitioning from traditional laboratories to non-traditional laboratories at post-secondary institutions?

Participants’ experiences indicate that faculty can transition to teaching online with NTLs with little support, training, available software, and no education in education itself. However, there will be complex elements in the transition that could be made more accessible. Theme one explains the need for support during the transition can occur through various pathways. All

participants experienced support of some type during their transition. The first subtheme of support was that the participants experience support in the form of another person, such as a colleague or instructional designer. In the second subtheme of support, the participant experienced support from a document such as a rubric. In the last subtheme of support, the participant experienced support from organized training from the institution.

The study's second theme was how the institution's infrastructure affected the participant during the experience and explained how things like initiation for transition, course preparations by the institution, and available software for labs affected the participant's experience. The subthemes were groupings of non-person things that played a role in the participant's experience during their transition. The third theme explained that the participants experience changes as a direct result of the transition. Subthemes were identified as the faculty member felt like a facilitator instead of a teacher, had less control, and was unsure of the effectiveness of NTLs in instruction due to the experience. The intention to transition did not seem to affect the transition, but no participant in the study expressed strong opposition to the initial transition. Rich said:

> I have been teaching for years, but none of my material was ready to throw online, so it was a lot of work on the front end, but the payoff was I could teach from anywhere, although most days that is my office. The point was, if I wanted to, I could travel.

Sub-Question One

What experiences facilitated the science faculty's transition from the pre-contemplation stage to the action stage as they incorporated non-traditional laboratories?

The TTM divides change into six stages (Prochaska et al., 2015). The first stage is the pre-contemplation stage, where the individual has not yet committed to the change. The second stage is the contemplation stage, where the individuals are committed to making the change

within the next six months. The second theme found in the current study was the effects of the infrastructure on the transition. The first subtheme of this theme was initiation, where participants discussed who or what initiated their transition to their new teaching roles using NTLs. The initiation subtheme was one element that facilitated the participants through the first two stages of the TTM. The participants were divided into two groups: those who were asked or transitioned to teaching online using NTLs by the institution and those who sought out teaching online using NTLs independently. It was found that the initiation did not negatively or positively impact the experience for the participants, but it did contribute to other themes and subthemes identified in the study.

Initiation had a significant connection to other subthemes, such as course preparation within the infrastructure of transition theme and training, a subtheme of the theme regarding support during the transition. The third stage of change, according to the TTM, is the preparation stage. Here, the individual plans to change and actively prepares for the transition (Prochaska et al., 2015). The individuals who were asked or told to start teaching online by the institution received less training than those who sought out teaching online themselves. This may have been because the institutions were creating their first online programs and did not have training available. The fourth stage of change within the TTM is the action stage, where the individual is actively engaged in making the change. The subtheme of training and course preparation was also apparent here, as the individuals would be going through training during the transition. The participants who received no training would be actively working on their self-learning of online education, using NTLs, and preparing their courses as they went through this stage.

The final theme also correlated to the first sub-question. The last theme was faculty's embracing change. The two subthemes were that the participants taught simultaneously at

multiple institutions and had all transitioned positions at specific career points. This spoke to the participants' willingness to put themselves in a situation where they would change. All participants displayed a level of flexibility within their careers as far as transitioning from different institutions and teaching at multiple institutions simultaneously, so it speaks to the type of faculty member who is open and willing to teach online science courses.

Sub-Question Two

What processes of change impacted the perception of science faculty towards non-traditional laboratories during their transition?

There are 10 identified processes of change within the TTM: consciousness-raising, dramatic relief, self-reevaluation, environment reevaluation, self-liberation, social liberation, counterconditioning, stimulus control, contingency management, and helping relationships. Social liberation and helping relationships occur when the person enduring the change experiences more opportunities and support. Social liberation and helping relationships were evident in the current study in the first theme, support during the transition. When going through these processes, the participants experienced support from people surrounding them, such as colleagues and instructional designers, which is grouped into subtheme teamwork. Participants also experienced support in the form of documents or guides, which were grouped into the second subtheme, guiding measures.

Counterconditioning, stimulus control, and contingency management occur during the action and maintenance stages. In the current study, this became apparent with faculty who expressed appreciation for online science options based on the needs of non-traditional students. Even those faculty members with reservations about the lack of laboratory experience acknowledged that the future includes online education, and science must be included. Jo

summarized this on the group forum, “You can’t fight the future when it is out of your control; you can only come up with ways to stay current and not get left behind. You do your best with the situation and find a way.”

Sub-Question Three

What experiences of science faculty influenced their plans for usage, or non-usage, of non-traditional laboratory formats after transitioning from traditional laboratories to non-traditional laboratories?

In addition to the six stages of change and the ten processes of change, decisional balance is also incorporated into the TTM. Decisional balance weighs the pros and cons of making the change. In the current study, all participants teach online, and no one shared plans to terminate their online positions. Some participants had moved on from the institution of their initial transition, but they were still teaching online at USNU or other institutions. The flexibility in time and additional income were encouraging factors for faculty who initiated the online teaching transition. Martha shared, “I wanted to stop commuting; I needed to get my courses approved to go online … I put it together and shared it with the department chair, and once it was approved, stop driving an hour each way.” The benefits of flexibility in the schedule and increased income seem to outweigh the drawbacks of losing control and role change.

Summary

Data collected from the science faculty participants through personal examples of NTLs used, interviews, and a focus group discussion board were analyzed and organized into four themes. The first theme identified was support provided to the participants during the transition from other individuals, documents, or training. The second theme identified was the effects of the infrastructure on the transition such as the initiation of the transition and course preparations.

The third theme found was how the participant's role changed during the transition when they either felt less like teachers and more like facilitators or when they felt they had less control. The final theme identified was the faculty's embracement of change overall. The participants faced significant changes during the transition from teaching traditional classes using TLs to teaching online using NTLs. Many were provided little guidance and little to no training, but none of the participants failed their transition. In fact, they preserved through and are content with their positions and future positions teaching NTLs. None of the participants shared any plans for terminating their online science courses that use NTLs.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study was to describe faculty's experience with change as they transition from using TLs to using NTLs at post-secondary institutions. This chapter discusses an analysis of the findings presented in chapter four. The following chapter includes the critical discussion, implications for policy and practice, theoretical and empirical implications, limitations and delimitations, and recommendations for future research.

Discussion

This section presents the study's findings concerning the discovered themes. The discussion includes a summary of the findings and the critical discussion. Following, the implications for practice and theoretical and empirical implications are presented. Finally, the limitations, delimitations, and recommendations for future research are discussed.

Summary of Thematic Findings

Data collection and analysis revealed four themes with several subthemes in the current study. The four themes are support during the transition, effects of infrastructure on the transition, faculty's change in role during the transition, and faculty embracement of change. The first theme, support during the transition, included three subthemes: teamwork, guiding measures, and training. The second theme, effects of infrastructure on the transition, included three subthemes: initiation, course preparation, and available lab software. The third theme, faculty's change in role during the transition, had three themes: facilitators instead of teachers, less control, and effectiveness of NTLs for learning. The fourth and final theme, faculty's embracement of change, included two subthemes: teaching at multiple institutions

simultaneously and transitioning positions. The themes are discussed in the following critical discussion.

Critical Discussion

The study revealed four significant findings between the literature review, data collection, and analysis. The first finding was that support during the transition was not required but could make a substantial difference in the experience. The second finding was that training and course preparation were linked together and impacted the workload for the faculty member. The third finding was that the faculty member teaching online experienced a shift in their professional role. The last finding was that teaching online using NTLs may be more suited for specific faculty members.

Support During the Transition. The first theme identified during the study was having support during the transition, which was identified as the first significant finding of the study. This support occurred in several ways, including people, documents, and training. Online education has become increasingly important in the last couple of years (Akbaba Altun & Johnson, 2022; Ali, 2020); however, support of online teaching faculty does not seem consistent. Many of the participants were offered little to no support during the transition. Although they were still successful in their transition, the participants who did receive support and training spoke positively of it. The literature stated that science faculty are more likely to make decisions based on their experiences and not empirical evidence alone (Daumiller et al., 2021; Eddy et al., 2019), and several models have been developed to aid in organizational change within the sciences (Reinholz & Andrews, 2020). It became clear that science faculty were capable of navigating the transition from TLs to NTLs without any help in many cases, speaking to a level

of independence and change-seeking behavior discussed later. Still, certain supportive elements can aid faculty during this transition and benefit them functionally and mentally.

Three forms of support were discussed during the study: people, documents, and training. Supporting people included knowledgeable colleagues and support staff outside the science departments, such as instruction designers. Science faculty were more likely to make changes when peers within the workplace supported them with time and resources (Andrews et al., 2016), and the motivation and skills of online science teachers increased with mentoring and training (Taufik & Yustina, 2020). Several studies have suggested that faculty support is a critical factor in increasing the effectiveness of online education (Elshami et al., 2021; Tartavulea et al., 2020). The study supported these findings. Having someone knowledgeable about the online platforms, learning outcomes for courses, and managing the learning management systems associated with online learning is beneficial for faculty, especially those with little or no experience teaching online. Instructional designers can work with institutions to identify instructional problems and find solutions (Stefaniak & Hwang, 2021). In James's interview, he expressed his appreciation of the instructional designer, stating, "That was my first introduction to instructional technology and instructional design… someone who had a few years of experience developing some online content." Science faculty may not have taken science courses online as students, so their exposure to the online learning world is often limited. A change in process is more challenging to relearn than it is to learn it in the initial procedure (Coch & French, 1948). During the interview, Jo stated:

> I had never used the type of lab software we were using, but my colleague that I was working with had, but she had never used the LMS, and I had. So, we just kind of taught each other the systems and made it work.

Having someone to go to with questions or someone on the team with experience, even when the staff member is unfamiliar with the science course content, can save time and stress for the faculty member. The second form of support was less impactful than the first and occurred in documents. These documents are not as helpful as human aid; however, they provide a starting point and minimal requirements when faculty develop online content. Several models measure online course quality (King & Nininger, 2019; Shraim, 2020), and there were a few guiding rubrics discussed by the participants, such as Quality Matters Rubrics.

Training and Course Preparations Connection. The last form of support was only identified in the participants hired to teach courses already offered online. The two subthemes, training and course preparation, are directly connected. Faculty that developed their courses with NTLs were not always provided with training. This seems to be because they were developing the first offerings of these courses. Several models are proposed to increase the quality of online education (King & Nininger, 2019; Shraim, 2020), so it seems training should always be offered, but that was not the case. Training on the learning management system is the most requested training for faculty (Coles et al., 2021). In the study, faculty hired to teach courses already offered online were provided training and felt they were ready to teach their courses at the end of the training. Laura acknowledged that she felt prepared to teach online after training when she stated, “They formatted the training just like our online classes would be formatted, so we got to be online students first and then were ready for the job.” Support and training during the transition were the most mentioned themes or subthemes and seemed to make the most significant difference in the participants’ experience. Several faculty members had gone through this transition at multiple institutions and could compare their experiences between the two. The connection between the course preparation and training or support became evident here.

The faculty member and the institution affected the experience of transitioning from teaching TLs to NTLs. All transitions were successful. Still, the ease at which the faculty member navigated the transition was linked to the institution's infrastructure. Preparation for an online course requires time and effective tools for producing a high-quality online learning environment (Hodges et al., 2020). As mentioned in the previous section, the front-end workload, the work to create and launch the online course is the first and largest task for the faculty member (Baldwin et al., 2018). This could be slightly decreased with support and training. Still, the most significant factor in reducing the front-end workload was preparing the course in a course shell or using predeveloped lab modules (Cruz, 2019; Eblen-Zayas, 2021).

Teaching online for the first time can be intimidating, especially for a generation where online learning was not an everyday part of their educational journeys (Cutri & Mena, 2020). Training for the learning management system and required technology can aid faculty in this transition (Eblen-Zayas, 2021) and there are faculty support programs designed to assist with the shift to online teaching (Bartlett et al., 2021). In situations where the participant faculty member transitioned their course online but was not offered any training, the faculty member was left to navigate the transition either on their own or with the help of peers in the same situation. Science faculty members can self-teach the online learning management system through trial and error and learning as they go, but it is time-consuming. This is supported in the literature that teaching online may increase schedule flexibility (Gülbahar, 2020; Stickney et al., 2019), but additional time may be required for the faculty member to set up and maintain an online classroom (Elshami et al., 2021; Mansback & Austin, 2018). Participants shared that to prepare the NTL, the faculty member must record demonstrations, select lab kits or virtual simulations, prepare labs, and go through the labs themselves several times to make sure the material fits the required

learning outcomes. William said during his interview, “Making the material is the hard part, writing out instructions and recording videos, that’s some time there.” Completing these tasks independently significantly increases the front-end work for the faculty member.

One way to decrease the front load work for the faculty member was to have a course shell prepared or lab software available. A course shell is where there are pre-loaded lessons or demonstrations that the faculty doesn’t have to provide for the course (Eblen-Zayas, 2021). The participants shared these are often created by the instructional designer or purchased from an outside source. When creating NTLs, faculty are challenged to provide students with hands-on and engaging activities while maintaining active learning (Basdogan & Birdwell, 2023; Dukes, 2020). Lab software with simulations has often been through several years of testing and student feedback, so they have been modified to best suit the needs of the student, and the faculty member does not have to create them from scratch. This was supported when Jessica stated, “I was very fortunate that many of the companies were giving out free software for the duration of the year.” The simulations usually must be purchased, so the cost must be absorbed by the institution or the student, which can cause other difficulties. Although these options saved the faculty member time and effort on the front end, they present other considerations concerning student budgeting, availability, and affordability.

Faculty’s Change in Role as an NTL Teacher. The third significant finding in the study was that faculty experienced a shift in their role when transitioning from teaching TLs to NTLs. Faculty in the study mentioned they felt less connected to the students, more like a facilitator or problem solver, and less like a teacher, when teaching online with NTLs. The change in role also resulted in the faculty feeling like they had less control in their new roles. These findings supported previous findings where the faculty reported feeling less of an expert and a loss of

identity (Cutri & Mena, 2020), difficulty connecting with students (Code et al., 2020; Korkmaz & Toraman, 2020), and less effectiveness as a teacher (Tartavulea et al., 2020). The faculty members' confidence in their ability to teach online did increase the longer they taught online (Eddy et al., 2019; Martin, Budhrani, et al., 2019). In a classroom setting, you interact with the students face-to-face synchronously. However, most online course material is prepared ahead of time, where the students access the material asynchronously, and the faculty member is not present (Martin, Budhrani, et al., 2019). Students in online courses may be in different time zones and have commitments outside of the classroom, so the asynchronous nature of the course is critical to their availability to access education. Still, it does come at the cost of connections with faculty and peers.

Unlike in a traditional setting, students using NTLs may only reach out to the faculty member when there is a problem with a course component. This situation left some of the participants in the study feeling like they were more of a problem solver than a teacher. These feelings were apparent when Jessica said during the interview, "I think my role became less of an instructor and more of a troubleshooter, like this isn't working, why isn't this working?" Technology is involved in many NTLs, so problems occur, and the students need help figuring out the issue. However, the problem is often not with the content but with the technology itself (Elshami et al., 2021). The faculty member may be unable to solve a technology issue and may have to direct the student to someone else (Esposito et al., 2021). In a traditional setting, problems in the lab can almost always be handled by the faculty member because they are more familiar with the equipment. Once the course begins, participants mentioned that the only interaction they may have with the students is grading assignments and providing feedback,

which is essentially a facilitator and not a teacher. Increasing instructor presence is a desire of many online teachers (Basdogan & Birdwell, 2023; Buelow et al., 2018; Coles et al., 2021)

Acceptance of Change. The fourth and final significant finding in the current study was that the participants all shared a tendency to transition between institutions and hold multiple positions simultaneously. The willingness to accept change is an important requirement for integrating the technology needed for online learning (Ali, 2020). One recommendation in the literature was that if higher education administration involved faculty in the consciousness-raising process, the faculty would be more likely to accept the changes taking place (Mitchell et al., 2015). All participants played an active role in the decision-making process pre-transition, so the study supports the literature's recommendations. Additionally, while it was not found in any of the literature reviewed, the ten participants all exhibited a change-seeking behavior professionally. All ten participants have taught at more than one institution during their careers and were teaching at more than one institute during the study. The reasoning for the transitions and positions varied between personal, professional, and financial ambitions. There are significant faculty shortages across all disciplines including sciences (Edwards et al., 2022; Jarosinski et al., 2022; Sabato et al., 2022), and more universities are turning to adjunct faculty to fill those vacancies (Bolitzer, 2019; Childress, 2019). It was unclear whether this commonality was due to the participant pool or if this was linked to the type of faculty willing and successful at teaching online with NTLs.

Implications for Policy or Practice

The findings of this study and the current literature offer implications for policy and practice. Policy implications include policies to ensure faculty members receive proper time, training, and support when asked to transition from teaching face-to-face with TLs to online with

NTLs. Practice implications mirror policies to focus on better training and support for faculty transitioning from teaching TLs to NTLs and better-informing faculty of the change in their role they may experience.

Implications for Policy

The current study found that faculty are not offered proper training, support, and a manageable workload when asked to transition their courses online; therefore, it may be beneficial for institutions to implement better policies to assist faculty with this transition. The transition from teaching in person with TLs to teaching online with NTLs can be a significant shift, and faculty have reported feeling less of an expert and losing their identity (Cutri & Mena, 2020). Faculty have resisted change in the past, which can cause problems for institutions (Abdurasulovich et al., 2020). The willingness to accept change is crucial for integrating the technology needed for online learning (Ali, 2020). Increased training and flexibility were found to increase the level of satisfaction in faculty teaching online (Gülbahar & Adnan, 2020; Stickney et al., 2019), and quality assurance and best practices were found helpful in directing the shift to online learning (Mohr & Shelton, 2017).

Implications for Practice

The study participants were not directly asked to contribute recommendations that would have aided their transitions. Still, based on the data collection analysis, several implications could be implemented to facilitate the transition more smoothly. The first implication for practice mirrors the need for better policies to mandate minimal training requirements for faculty transitioning to teaching online and ensure this training is of good quality. This training might be provided by an outside source for the specific learning management system or teaching online practices. Participants in the study praised USNU training for being offered in the same format as

the courses they were hired to teach. This allowed them to experience the class as students and learn to teach online. This parallel could possibly be formatted similarly at other institutions if they implemented training within their programs.

The second implication for practice is to inform faculty better about what role changes they may experience as an online teacher using NTLs if they are navigating this transition for the first time. Early awareness could be achieved in the initial job ads or during interviewing. Literature recommended that faculty be part of the decision or involved in the transition (Mitchell et al., 2015). Participants in the study felt they had a hard time connecting with students and were more of a facilitator than a teacher. After experiencing the transition and the shift in the role, the participants planned to remain in the online roles. Their continued online position implied that the change in role was not disruptive enough to terminate their positions, but going into the experience knowing what to expect may aid the transition for any faculty member, not just in the science discipline.

Empirical and Theoretical Implications

This study offers theoretical and empirical implications. It extends the application of the TTM to a new area, including faculty transitioning from teaching traditional classes with TLs to online courses with NTLs. This study includes unique insight into experiences with change that science faculty experience when navigating the TL to NTL transition. This study also extends the empirical knowledge by exploring the experience of the science faculty, which is not included in the current literature.

Empirical Implications

Four implications related to existing literature emerged from this study's results. They are acceptance of change, the change in role for the faculty member as an NTL teacher, values for laboratory exercises in all science courses, and values for NTLs. Each is discussed below.

Acceptance of Change. The experiences of science faculty transitioning from teaching traditional courses with TLs to teaching online using NTLs have not been documented in the literature, so the research findings from the current study expand on the existing literature. Change is often met with resistance (Prochaska et al., 2015), which must be countered for successful organizational change (Abdurasulovich et al., 2020; Ali, 2020). Science faculty are not excluded from the average response to organizational change and have resisted change even when empirical evidence has supported the shift (Andrews & Lemons, 2015; Eddy et al., 2019). However, the current study did not find that participants resisted the transition to online teaching using NTLs. The participants in the study seemed to welcome and seek change in their careers by transitioning between institutions and positions. Jessica specifically stated, "I feel like if I stay in the same place too long, I get stale, you have to switch things up." Eight of the ten participants in the study were recruited from a large online institution that employs many adjunct professors, so it was not surprising that all participants held multiple positions at various institutions. It is not clear if this acceptance to change was partially due to the participant pool, their science background, or the type of faculty members that may seek these roles.

Changes in Role as NTL teachers. Although the study participants accepted their change in positions, they did experience changes in their roles that supported the literature findings. These findings supported previous findings where the faculty reported feeling less of an expert and losing their identity (Cutri & Mena, 2020), having difficulty connecting with students

(Code et al., 2020; Korkmaz & Toraman, 2020), and less effectiveness as a teacher (Tartavulea et al., 2020). However, the current research extends these previous findings as these changes in their roles were not significant enough to cause the faculty member to terminate their positions. Furthermore, six of the ten participants mentioned that while they did experience a shift in their role, they understood that online learning was still effective and greatly needed for non-traditional students. Tasha stated that she did not enjoy teaching online but would continue doing it because it allowed her to care for her husband at home.

Value of NTLs. In addition to the faculty's change, the value of science laboratory exercises was also researched and discussed during the interviews. There is a belief by many that in-person instruction works better than online courses (Newton, 2020). Science courses are often required for all majors for post-secondary degrees; however, science courses are offered less usually online than other general education courses (Varty, 2016) and research opportunities are scarce (Levin, & Grewe, 2020). The laboratory exercises allow students to apply the concepts they cover to real-life situations, and students perform better when laboratory components are included in science courses (DeBoer et al., 2019; Goacher et al., 2017). Six of the ten participants mentioned that it was important for science courses to include laboratory exercises, including online courses. This study extends the knowledge that faculty support the inclusion of a laboratory component in science courses, even when offered in an online format (Levin, & Grewe, 2020; Dukes, 2020). All participants in the current study agreed that NTLs were a necessary component of online science courses and that non-traditional students with no other options need NTLs to fulfill those learning outcomes.

Although faculty opinions on NTLs were directly inquired through the interviews and discussion posts, several topics emerged about the value of NTLs in science. The learning

outcomes of laboratory work are not dependent on the location of the lab, and NTLs allow students to self-pace, restart, reset, and repeat activities around the clock, whereas TLs are limited to lab hours (Hernández-de-Menéndez et al., 2019). Technological advances have made laboratories outside the traditional science lab possible. NTLs can occur online virtually where the student observes an experiment through video, controls equipment virtually through online programs, or carries out an experiment with equipment from a lab kit in their homes (Faulconer & Gruss, 2018; Kolil et al., 2020). Increased access was supported when faculty participants commented that the students must navigate the lab instructions themselves and often repeat steps in the lab exercise if they made a mistake, increasing their time spent with the material. Mary shared that she thought the at-home labs were harder than face-to-face because the students must read the directions, follow the instructions, and not ask for help. Four participants mentioned that it was a good thing for students to realize that there will be mistakes made in professional research, and they must go back over their work and figure out what they did wrong. Six participants mentioned that while the experience between the professor, student, and equipment may not be the same, the critical components of the purpose of the lab exercise are still possible and necessary for non-traditional students.

Theoretical Implications

The theory this study's results can be associated with is the theoretical framework, the TTM (Prochaska et al., 2015). The paragraphs below address the significance of the theory regarding the current study's findings. The TTM served as the theoretical framework for the current study. The TTM is not widely used in education; however, it was used to examine faculty's readiness to teach online (Mitchell et al., 2015). The current study expanded the use of the TTM to discuss the faculty's experience with change as they navigated the transition from

teaching TLs to NTLs. The study reflects the TTM and found that the faculty members guide the ten processes of change as they go through the six stages.

Limitations and Delimitations

In the study, two limitations and two delimitations were identified. Limitations include the racial background of the participants and the limited recruitment sites. Delimitations include limiting participants to science faculty and using the transcendental approach instead of hermeneutical one. Limitations and delimitation are discussed in the following paragraphs.

Limitations

Limitations to research may include underlying theories, relationships, settings, samples, data collection and interpretations (Theofanidis & Fountouki, 2019). Limitations to the current study involved participants' racial backgrounds and institutional recruitment. The study included a majority of White participants with only one minority representative. Additionally, eight participants were recruited from one institution, which is an online-only institution. However, most participants discussed this transition at other institutions other than USNU. When the theme emerged that all participants had transitioned positions through their careers and did not avoid change, I wondered if that was due to the pool of participants I recruited from or if that was true across the science field.

Delimitations

Delimitations occur when the researcher makes limits to the boundaries of the study (Theofanidis & Fountouki, 201p). Delimitation within the current study included the inclusion of only faculty that have used NTLs within the science department and using a transcendental approach. Initially planning for the study, I had designed to recruit STEM faculty to broaden the possibility of participating. However, upon further evaluation, I chose to limit participants to

science faculty because they would have used more similar laboratory exercises. Because I have only taught biology NTLs at my employers, I cannot fully share participants' experiences outside that discipline or institution, so I chose the transcendental approach instead of the hermeneutical one. This limitation would have omitted participants from other institutions and teaching in fields outside of science.

Recommendations for Future Research

Regarding recommendations for future research, several possibilities are worth considering. Recommendations concern expanding participant criteria and research methods. All participants were teaching online, meaning they had successfully navigated the transition being examined. Expanding the participant pool to others who did not complete the transition or were only introduced briefly online would allow a more thorough examination of the challenges. Additionally, expanding sites to include small universities without a sizeable online population would include participants who navigated this transition with a different infrastructure. A study where all the particpants had navigated the same transition at one institution would allow a better examination of the individual's similiarties and differences with less variables and more controls.

Recruiting was especially difficult as faculty usually have heavy teaching loads and hectic schedules. Although a survey-based study was not selected in the current plan because of the limitations to understanding the phenomenon, a mixed methods study that employed both surveys and interviews would allow significant data input. Faculty who cannot commit to the time for an interview may be willing to contribute to a study, and those who want to follow up the survey with an interview would also allow the qualitative approach.

Further research on how to best support and train faculty facing the transition to teaching online with NTLs is also needed. Further research should start with a quantitative survey design

where a maximal amount of faculty could respond with their opinion on how they wish to be supported during this transition. Based on the outcome of that research, case studies should be implemented following faculty as they transition from using TLs to NTLs. Support can include people, documents, or training but examining which of these is the most successful would aid institutions in guiding faculty through this time. Further examination into what type of training was most helpful should also be considered, especially training on increasing faculty presence in online courses and NTLs.

Conclusion

The participants in the study preserved through the transition from teaching traditional courses with TLs to online classes with NTLs with little to no support and plan to continue teaching online. Jo said, “Online education is where we’re going, it is the future whether we want to adapt or not, and it is up to us to keep our material relevant and effective online.” Participants in the study, science faculty members, appreciate the value of NTLs for non-traditional students even though they experience changes in their own roles as NTL teachers. Several factors should be considered to make this transition smoother for faculty. Offering support to the faculty member transitioning was found to be beneficial. Course preparations and lab availability decrease the front-end workload for the faculty members. The participants experienced changes in their roles once teaching online with NTLs, but these changes were balanced with their understanding of the need for online learning for non-traditional students. For these reasons, science faculty must continue to embrace change and adjust as education continues to expand in the online world.

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APPENDIX A

Liberty University IRB Approval

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To:
Sub

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

May 30, 2023

Jessie Bostic
Kristy Motte

Re: IRB Exemption - IRB-FY22-23-1603 A TRANSCENDENTAL PHENOMENOLOGICAL STUDY EXAMINING SCIENCE FACULTY EXPERIENCES WITH CHANGE WHEN TRANSITIONING FROM TRADITIONAL LABORATORIES TO NON-TRADITIONAL LABORATORIES

Dear Jessie Bostic, Kristy Motte,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(iii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s)

should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

[redacted]

APPENDIX B

Participating Institution IRB Approval

American Public University System
American Military University
American Public University

Institutional Research Review Board (IRRB)

Application Number: 2023-055

Application Title: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY EXAMINING SCIENCE FACULTY EXPERIENCES WITH CHANGE WHEN TRANSITIONING FROM TRADITIONAL LABORATORIES TO NON-TRADITIONAL LABORATORIES

06/06/2023

Dear Jessica Bostic,

The APUS IRB has reviewed and approved the above application.

Date of IRB approval: **06/06/2023**

Date of IRB approval expiration: **06/05/2024**

The approval is valid until the date indicated above. Should your research using human subjects extend beyond the time covered by this approval, you will need to submit a *continuing review form* to the IRB. Work with your department leadership to obtain a list of participants to recruit for your study.

Changes in the research (e.g., recruitment process, advertisements) or informed consent process must be approved by the IRB before they are implemented. Please submit a *protocol amendment form* to do so.

It is the responsibility of the investigators to report to the IRRB any serious, unexpected, and related adverse events and potential unanticipated problems related to risks to subjects and others using the *unanticipated problems notification*.

Please direct any question to apus-irb@apus.edu. The forms mentioned above are available at http://www.apus.edu/community-scholars/institutional-review-board/apply.htm.

Sincerely,

[redacted]

APPENDIX C

Invitational Email for Participation

Dear Potential Participant,

As a doctoral candidate in the School of Education at Liberty University, I am conducting research examining the transition that science faculty experience when they begin teaching non-traditional laboratories as part of the requirements for a doctoral degree. The purpose of my research is to provide insight into this transition, examining the experiences with change that may take place, and I am writing to invite you to join my study.

Participants must be faculty teaching science courses, either part-time or full-time, with one full year experience using non-traditional laboratories outside the COVID-19 pandemic. Participants will be asked to submit a non-traditional lab exercise they have transitioned from a traditional lab to a non-traditional lab, participate in an individual virtual interview, and participate in an online focus group forum (discussion board). It should take approximately 1 hour for the interview, and 30 minutes for the focus group forum. Names and other identifying information will be requested as part of this study, but participant identities will not be disclosed.

To participate, please click here https://www.surveymonkey.com/r/JBLNNN6 to complete the screening survey. If you meet my participant criteria, I will contact you to submit a non-traditional lab example and schedule a time for an interview.

A consent document is attached to this email. The consent document contains additional information about my research. If you choose to participate, you will need to sign the consent document and return it to me when you submit the lab example.

Sincerely,

Jessie Bostic
Ph. D. Candidate
[redacted]

APPENDIX D

Participant Screening Survey for Qualifications

Potiential Participant Screening Form

As a doctoral candidate in the School of Education at Liberty University, I am conducting research examining the transition that science faculty experience when they begin teaching non-traditional laboratories as part of the requirements for a doctoral degree. The purpose of my research is to provide insight into this transition, examining the experiences with change that may take place.

Question Title

1. What is your full name?

Question Title

2. Please list your degrees, majors, and the year they were earned.

Question Title

3. What is your age range/

- 25-34
- 35-44
- 45-54
- 55-64
- 65+

Question Title

4. Which race/ethnicity best describes you? (Please choose only one.)

- American Indian or Alaskan Native
- Asian / Pacific Islander
- Black or African American
- Hispanic
- White / Caucasian
- Multiple ethnicity / Other (please specify)

Question Title

5. Please provide the name of the organization you teach with and if it is a private for-profit, private non-profit, or public institution.

Question Title

6. Approximately what year did you first teach an online science course that included a non-traditional (virtual, online, remote, etc) lab?

Question Title

7. Approximately how long (years/months) combined have you taught online courses that include a non-traditional (virtual, online, remote, etc) lab excluding any courses that were transitioned to an online format as a result of the pandemic?

Question Title

8. Did you teach online due to the pandemic?

- Yes, my face-to-face classes were transitioned to online versions as a result of the pandemic.
- No, my classes all remained face-to-face.
- Yes, I was already teaching online courses, so the pandemic did not effect my instructional platform.

Other (please explain your online presence during the pandemic)

Question Title

9. Please include any other information you believe would be helpful in the selection process for participants.

D

APPENDIX E

Participant Interview Second Invitational Email

Dear Potential Participant,

As a doctoral candidate in the School of Education at Liberty University, I am conducting research examining the transition that science faculty experience when they begin teaching non-traditional laboratories as part of the requirements for a doctoral degree. The purpose of my research is to provide insight into this transition, examining the experiences with change that may take place, and I am writing to invite you to join my study.

After reviewing the screening survey, I am pleased to invite you to schedule an interview. Please reply to this email with the following items.

1. Use the calendar link shared to schedule an interview.
2. Signed consent form (attached)
3. An example of a non-traditional lab you have used in the past.

It should take approximately 1 hour for the interview and 30 minutes for the focus group forum. Names and other identifying information will be requested for this study, but participant identities will not be disclosed.

A consent document is attached to this email. The consent document contains additional information about my research. If you choose to participate, you must sign the consent document and return it to me when you submit the lab example.

Sincerely,

Jessie Bostic
Ph. D. Candidate
[redacted]

APPENDIX F

Consent Form

Title of the Project: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY EXAMINING SCIENCE FACULTY EXPERIENCES WITH CHANGE WHEN TRANSITIONING FROM TRADITIONAL LABORATORIES TO NON-TRADITIONAL LABORATORIES
Principal Investigator: Jessie Bostic, Doctoral Candidate, School of Education, Liberty

Invitation to be Part of a Research Study

You are invited to participate in a research study. To participate, you must be college science faculty member with experience using non-traditional laboratories. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

What is the study about and why is it being done?

The purpose of the study is to describe faculty's experience with change as they transition from using traditional laboratories to non-traditional laboratories at the college level.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following:

1. Submit an example through email of a lab exercise or activity you have transitioned from an in person traditional lab format to a non-traditional lab format. The estimated time for this process should be about 20 minutes. Your example will not be shared, published, or included in the final manuscript.
2. Participate in an individual virtual interview that should take about an hour. The interview can be audio only or video based on your preference. The interview will be recorded for data collection purposes. The video will not be shared..
3. Participate in a discussion forum with other participants in the study. This forum should take about 30–60 minutes and will be open for a week. This focus group will be recorded, but the recordings will not be shared.
4. Review the developed themes from your participation, this should take no more than 30 minutes.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include a better understanding of the transition faculty endure when transitioning laboratories to non-traditional formats to accompany online science courses.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses will be kept confidential by replacing names with pseudonyms.
- Interviews will be conducted in a location where others will not easily overhear the conversation.
- Confidentiality cannot be guaranteed in focus group settings, but only pseudonyms will be used for participants on the forum. While discouraged, other members of the focus group may share what was discussed with people outside of the group.
- Data collected from you may be used in future research studies. If data collected from you is reused or shared, any information that could identify you, if applicable, will be removed beforehand.
- Data will be stored on a password-locked computer or in a locked file cabinet. After five years, all electronic records will be deleted, and all hardcopy records will be shredded.
- Recordings will be stored on a password locked computer for five years and then deleted. The researcher will have access to these recordings.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Jessie Bostic. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted] You may also contact the researcher's faculty sponsor, Dr. Motte, a[redacted]

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the IRB. Our physical address is Institutional Review Board, [redacted] 24515; our phone number is [redacted]

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to record me as part of my participation in this study.

_____
Printed Subject Name

_____
Signature & Date

APPENDIX G

Researcher's Responses to Interview Questions

1. Please introduce yourself to me as if we had just met one another.

Hello, I am Jessie, and I am a Biology Professor. I have taught at the college level for nine years. I teach various biology courses online and in person at several different institutions.

2. Please walk me through an overview of your career.

I began teaching high school immediately after graduating with a bachelor's degree in biology. My bachelor's degree was earned in person at a traditional four-year university. I did not do any online coursework in the undergraduate program. I did not enjoy teaching at the high school level and wanted to be able to teach at the college level, so I began a hybrid graduate program. All coursework for my Master's degree was online, and research was done locally with a mentor. The hybrid program included summer courses you could take in person at the university. After graduating, I immediately started teaching as an adjunct professor. I was an adjunct professor for five years when I decided to return to school again to earn my PhD. I chose the Instructional Design and Technology degree to understand course design and available technology better. I was also parenting three children, so I needed the flexibility to continue working while attending school, excluding a Ph.D. in Biology, as all programs were in person and required heavy time commitments. I was hired in 2022 as a full-time faculty member at the institution where I previously worked as an adjunct professor.

3. Please tell me about your experiences with laboratories as a student, for example, while earning your degrees.

All of the undergraduate labs I took were in person on campus. After graduating, I took two online courses while teaching high school as prerequisites for a nursing program I had wanted to attend. One was Human Anatomy and Physiology, and dissections were required. They mailed the dissection kit to your home. The kit included a fetal pig, a sheep brain, and a sheep heart. I was to record myself completing the dissections and upload my lab report and video to the LMS. This was my first experience with NTLs, and it changed my career path. As a non-traditional student with two small children and a full-time job, I couldn't take science courses on campus in the middle of the day. Still, I could do the dissections in my kitchen following the lab demonstration video. I did great in the course but decided against the nursing program and started looking for online Biology Master programs. They were very limited; I only found one and was admitted. All my coursework was online in the master's program, so I continued working and raising my growing family. The labs were all virtual, and the research was done locally with a mentor. During the research, we video-conferenced with our advisor weekly. I did field research capturing box turtles and evaluating capture methods. So, I could do hands-on fieldwork through a virtual program, furthering my interest in non-traditional laboratory work.

4. Please walk me through a timeline of your experiences with traditional laboratories.

As an adjunct professor and now in my full-time position, I teach traditional face-to-face courses with traditional laboratories. I have taught General Biology, Human A&P, Genetics, and Vertebrate Morphology in the traditional laboratory. I set up the labs as we are a small

liberal arts college with no TA or lab manager. I then teach each week in addition to the class time. I started teaching these types of labs nine years ago at the beginning of my professor career and still teach them today.

5. How do you currently use non-traditional laboratories?

In my full-time role, I have developed an online general biology course with non-traditional laboratories. I use a combination of at-home labs where the students use material found around their house and virtual simulation labs through Mastering Labs with Pearson. In my adjunct role with the more prominent online-only institution, I also teach General Biology. I did not design these courses or the lab material, but I facilitated using them within the course. They use lab kits mailed to the student's home and do the lab independently. They must submit photos with time cards as proof of their work done. They also use virtual simulation labs through Interactive Science.

6. Please only include experiences before the Covid-19 pandemic for the next two questions. Please spend as much time as necessary on these questions, as they are the essence of the interview. What led you to transition from using traditional laboratories to non-traditional laboratories?

I have gone through this transition several times now. The first time was as an adjunct, and I was hired to teach an online course that used lab kits mailed to the student's home. I underwent training for several weeks and was given a lab kit. We were asked to make helpful guides or videos that personalized the learning experience and helped the students with tricky procedures. I did not write these labs, but I had to learn the process of each one so I could assist students when they had questions or problems. I was already teaching online during the pandemic, so it did not affect my courses. After the pandemic, I was hired into my current full-time role and was asked to create a general biology course for online students at our small liberal arts school. General Biology had not been offered online before, so I created the course and labs from scratch. I had experience teaching online for the last four years, so I knew available software and formatting, which helped. My two colleagues had never taught online outside of the pandemic, so when I was hired, I was asked about my willingness to develop some courses online. I now offer this course online each summer and will hopefully provide more in the future.

7. Please share your experience transitioning from traditional laboratories to non-traditional laboratories.

Since I was offered thorough training through my first transition, I feel like I had a good start in the online world of science. I had also already finished a hybrid biology graduate program when many of our labs used virtual and remote options, so I was very familiar with the concepts. I did not feel like the transition was that difficult to make in my case. When I created the course from scratch, it was time-intensive to make all the lessons and assignments, but now I have a course shell that I can use each time. So, it was work intensive on the front end, but not so bad after offering it the first time. I don't feel like teaching online really saves me any time; if anything, I put more time into grading and communicating with students than I do in a face-to-face lab, but it is more flexible, obviously. I can work from home in my sweats if I want to, though I usually like my office more.

8. Please walk me through the example of a non-traditional lab you shared with me as if I was an observer during the time you used the lab.

One lab I transitioned to a remote lab uses roll-polli bugs to look at animal behavior. The student goes out into their yard and collects a few bugs in a container. Then, they go through an experiment looking at how the bugs respond to light and moisture. They have to submit images with their lab report. The students really enjoyed it and gave me great feedback.

9. What aspects of the sample lab were challenging to transfer to a non-traditional format?

Writing up the lab report instructions and template takes a long time. Otherwise, it's no different than doing the lab in the lab with the students; instead of verbally telling them the instructions, I just had to write them out step by step. Now I have it ready to do, though so it's easy.

10. How did you use non-traditional labs during the COVID-19 pandemic?

I was already teaching only online during the pandemic because I left my face-to-face adjunct position in the spring of 2019, so it didn't change anything for me.

11. How do you think you will use non-traditional laboratories in the future?

This is my passion and interest in my field, and I feel like I can make a difference somewhere. There are tons of students that, because of their careers and families, cannot take traditional science courses on a campus, but they should still be able to major in science and take science courses that expose them to our world. I am not saying to put medical school programs online, but it should be an option where it's appropriate. So I'll use them as much as possible.

12. We have covered much ground in our conversation, and I so appreciate the time you've given to this. One final question… What else would you think would be essential for me to know about your experience transitioning from traditional laboratories to non-traditional laboratories?

APPENDIX H

Individual Interview Questions

1. Please introduce yourself to me as if we had just met one another.
2. Please walk me through an overview of your career.
3. Please tell me about your experiences with laboratories as a student, for example, while earning your degrees.
4. Please walk me through a timeline of your experiences with traditional laboratories.
5. How do you currently use non-traditional laboratories?
6. Please only include experiences before the COVID-19 pandemic for the next two questions. Please spend as much time as necessary on these questions, as they are the essence of the interview. What led you to transition from using traditional laboratories to non-traditional laboratories?
7. Please share your experience transitioning from traditional laboratories to non-traditional laboratories.
8. Please walk me through the example of a non-traditional lab you shared with me as if I was an observer during the time you used the lab.
9. What aspects of the sample lab were challenging to transfer to a non-traditional format?
10. How did you use non-traditional labs during the COVID-19 pandemic?
11. How do you think you will use non-traditional laboratories in the future?
12. We have covered much ground in our conversation, and I so appreciate the time you've given to this. One final question: What else would you think would be essential for me to know about your experience transitioning from traditional laboratories to non-traditional laboratories?

APPENDIX I

Example NTL With Researcher Notations

MEASUREMENT, BALANCING EQUATION, ATOMS, MOLECULES

PURPOSE

Summary: Participant 1 has students use their textbooks to do basic measurements and calculations using the metric system. Students should understand how to use conversion factors in calculation and balancing equations. The goal is an understanding of atoms and molecules.

Researcher Question: Who wrote the learning outcomes for this lab? Did you have to write new ones that were different from the face-to-face lab?

EQUIPMENT AND MATERIALS (Everything is in your lab kit!)

Summary: Participant 1 has students pick up materials from the school at the start of the term of they are mailed to the student's house. There are some other required materials that are not in the kit that are commonly found in most households.

Researcher Question: Who prepared the kits? How much did they cost the student? Did all of the students buy them? What happens if they don't? Did this take more or less time than weekly lab prep with a face-to-face lab? If something was left out of the kit, who's responsibility was it to get the item to the student?

PROCEDURE

Summary: Participant 1 provided detailed descriptions of the steps in the lab, including definitions, examples, equations, and steps to follow. The lab included the following concepts –

A. FIND THE VOLUME OF THE WOODEN BLOCK (INCLUDE UNITS AND SHOW CALCULATIONS FOR CREDIT.)
B. FIND THE AREA OF THE BOX OF PAPER CLIPS. (INCLUDE UNITS AND SHOW CALCULATIONS FOR CREDIT.)
C. DETERMINE CONVERSION FACTORS FROM COMMON HOUSEHOLD ITEMS
D. BALANCING EQUATIONS
E. BUILDING ATOMS
F. BUILDING MOLECULES

Researcher Comments/Questions: This was a very lengthy and thorough lab that must have taken a long time to write and complete. Did the participant have help in this process? Did you use tools already available online or did you write everything from scratch? Can this lab be used in other courses or other sections of this course in the future?

APPENDIX J

Noted Transcript of Jessica's Interview

Participant Jessica: Hi, how are you?

Bostic, Jessie: Hi, I'm good. How are you doing? Very nice to meet you. I'm Jessie.

Participant Jessica: Nice to meet you as well.

Bostic, Jessie: Yeah. And I really like the lab examples that you sent me.

Participant Jessica: Thank you.

Bostic, Jessie: They were very helpful and very well thought out. Did you or I'll get to that, I guess. But I was gonna say, did you write all those like yourself, or was it a team effort or?

(Team Effort)

Participant Jessica: It was some of them I wrote myself, and some of them, it was a team effort, yeah.

Bostic, Jessie: OK, umm, I'm trying to get my screen straight here. I moved my screen stuff and now it's disappeared.

Participant Jessica: Mm-hmm.

Bostic, Jessie: Can you give me a brief introduction to yourself?

(Demographic/Experience)

Participant Jessica: Sure. My name is [hidden].

I've been teaching full-time since 2010. I have a bachelor's in chemistry, a master's in chemistry, and in December I finished my education doctorate because much like you, I was teaching thinking. Hmm. It's so funny that they just release you into this world of teaching with no absolutely no teaching skills. So, I finished my education doctorate from Baylor in just in December. I recently up until a year ago, I transitioned from teaching postsecondary to high school, but I also maintain my adjunct position at APUS.

Bostic, Jessie: Nice.

Participant Jessica: I think you're like the biology equivalent of what I did. I just. I was like, I really wanna do something more. I want to figure out how we can better educate our students. I flip-flopped around between an instructional design degree and an education degree, but I wanted the education route just because I was teaching a college course on basically how to teach teachers. So I was, you know, for the education department.

Bostic, Jessie: OK.

Participant Jessica: So, I was kind of like, oh, maybe I'll go that route. So, but yeah, I've been teaching for a long time now. Feels like forever, but yeah, just to about a year ago I transitioned to a high school position.

Bostic, Jessie: OK.

(Transitioning positions)

Participant Jessica: Just wanted those. Well, to be honest, I got stuck in the virtual world I was teaching online long before COVID hit, and then when COVID did hit, I transitioned almost entirely online and I just got tired of sitting behind the computer all the time. So I was like looking just looking for a different opportunity, something I could get back in the classroom with so, but yeah, I've been, I we did just transition at APUS into the virtual chemistry as well.

Bostic, Jessie: OK, so it does sound like very similar pathways and I kind of did the same I was online before COVID.

Participant Jessica: Exactly, yes. Exactly. I feel like if you stay at one place too long, you get stale. *Bostic, Jessie: Yes.*

Participant Jessica: Get you know you need to change it up and I've been pretty regular about changing my job about every five years. Umm, I thought I'd be one of those long-term people, you know?

Bostic, Jessie: Yeah.

Participant Jessica: Stay at a place forever. But my husband was like, you know, you get paid better when you go somewhere else. You know, you change up, you know, get reinvigorated. So that's kinda then our thing. I probably won't ever earn that 30-year pin, unfortunately, so.

Bostic, Jessie: So, I've kind of got an idea of your career as a student. Did you have any online, like earning your degrees? I imagine your education one was probably was it online or a hybrid?

Participant Jessica: It was virtual, yeah. Mm-hmm.

Bostic, Jessie: OK, now with your bachelor's and master's, did you do any online coursework with those?

(No online coursework as a student)

Participant Jessica: I did, but none in my field. They were all like the core classes that I was required to complete, but no, no actual science ones that I complete online.

Bostic, Jessie: OK, alright.

Bostic, Jessie: What in your, I'm assuming now teaching high school everything's face-to-face?

Participant Jessica: Yes.

Bostic, Jessie: And have you taught college labs face to face, or what was your college experience?

Participant Jessica: Yes, I taught college labs, virtual, hybrid, and face to face so.

Bostic, Jessie: OK. Can you give me an example of like some courses maybe that you did face to face and in more than one format or were those the ones that you sent me?

(Working with colleagues for transition)

Participant Jessica: Yeah, those were kind of my introductory ones. So that will those are labs that we transition. So when I said they were somewhere group, you know, somewhere a group effort and somewhere together what happened is when I started teaching in 2010, they had what we generically called the liberal arts Chemistry. This the chemistry for non science majors who need that credit and it was being offered as a hybrid.

Bostic, Jessie: Right.

Participant Jessica: So, we were teaching the lecture online and then they would show up one day a week to complete the lab. The lab was basically those eight labs that you saw there. Those were the ones we were completing in person and then we slowly the demand at our school for more online accessibility came along. And so we transitioned those essentially those lab from it in lab one to one that they could complete at home. So those are the ones that we transitioned from a face to face to an virtual lab assignment. This was also long before there were mini virtual experimentation options and stuff like we have now.

Bostic, Jessie: Right.

(lab kits)

Participant Jessica: We tossed around the idea of them purchasing lab kits and completing them at home, but mostly we decided we liked them using things they could easily accessible, like easily accessible. They could go find, or maybe every now and then they'd have to pick up something from us if they couldn't find it or whatever. We thought that was more cost effective for our students in the long run.

Bostic, Jessie: OK. So, the lab kit that you reference, like the wood block, is that something y'all just sent to them then?

Participant Jessica: Yes, we would have, we would have just like basically make a little generic lab kit that they would check out and then they would have to turn back in at the end.

Bostic, Jessie: Oh OK.

Participant Jessica: So, it was a just like I said, something more cost effective. Some of those actual kits could be quite expensive, so we tried to keep the cost down.

Bostic, Jessie: So can you tell me about that transition like I guess just overall experience of transitioning those to online as far as how y'all did it and decided, you know, what was the driving force then?

(Hands-on labs)

Participant Jessica: So yes. The driving force behind our transition to a online process is we wanted to keep the keep the students being hands on. This being a non science majors course, it made it a little bit easier because when we transitioned, it was still fun to bring in things like, oh, this is just a common thing that you can have in your house and look at what you can do with it. So it was kind of fun in that aspect as well. At the time, I don't know if you saw the nuclear chemistry lab that we would do. It wasn't, you know, that was just kind of like the newest technology of the time is that augmented reality, which is not, you know so much anymore.

Bostic, Jessie: Right.

Participant Jessica: But that was kind of a fun little activity, but we really wanted them to stay as hands-on as much as possible. I feel like I'm probably venturing off task here, but like I feel like the virtual labs that we do now for actual science majors are somewhat frustrating. I don't think they're getting that hands-on experience that they need and it makes me very worried about how they will transition into other courses and into other degrees that they're seeking without that hands-on. Like really tweaking the glassware and seeing how much it takes to get that one little drop in a titration or whatever the case may be. So, that was our biggest push.

Bostic, Jessie: This pipette is tricky, I agree.

Participant Jessica: Yeah, that's why I was like, I feel like that was our biggest push in all of the labs I've ever transitioned into a virtual lab. My goal has always been to still have them being hands-on as much as possible, so and so.

Bostic, Jessie: Right. So, imagine [USNU] is a transition you weren't necessarily in favor.

(virtual labs)

Participant Jessica: I was not. I was not in favor of it and I voiced that opinion. But you know it's it is what it is. The lab kits aren't great, I agree. There's needs to be some other, better option that was not, you know, it's really hard. We're going all online, but yeah, the virtual labs, I feel like, yeah, they're fun. But are they really grasping the lab element that they need in the course?

Bostic, Jessie: Yeah.

Participant Jessica: And that's why I feel a lot of it's getting lost so.

Bostic, Jessie: Yes. How do you think your role changed as you transition those face to face ones to traditional?

(change in role)

Participant Jessica: Yeah, well, that's a good question, because I think my role became less of an instructor and more of a troubleshooter like this isn't working. Why isn't it working? And yes, sometimes it became a a good learning experience like ohh it's not doing this, and you could explain the chemistry behind it and sometimes it was sheerly because you know they the equipment wasn't working correctly and there's no good way to describe it. So, there's lots of, can you see me a picture of what's happening? Let you know I very much became more of a troubleshooter and less of a chemistry teacher in my opinion, so that was one of the biggest, like role adjustments that I made is I feel like I'm not really teaching them about chemistry anymore.

Bostic, Jessie: Yes.

Participant Jessica: I'm teaching them about technology and how to do this and how to do that so but.

Bostic, Jessie: Yes. And do you feel like that's part of the maybe drive to go back to face to face, as you wanted that?

Participant Jessica: Yes. Yeah, that was it. I was very much ready to get more hands on and less behind the computer. I just love being in the classroom. I'm really good at virtual. That's why they basically transitioned me to all these virtual things at [previous employer], But I got tired of it. I spent 40 hours a week sitting behind my computer troubleshooting what was going on. My husband and I are committed to making that transition and this first year I've loved it.

Bostic, Jessie: Yes.

Participant Jessica: Like, yes, the students can be something else, but yeah, but I've loved it. I have a I have a five and seven year old right now. And so that's part of it is I took a little step back and the fact that I have a lot more flexibility now while my kids are getting into activities and stuff at a younger age.

Bostic, Jessie: Right.

Participant Jessica: So, I really enjoy that as well, but that's beside the point. But yeah, really that troubleshooting aspect. The fact that I was just behind the computer, answering silly questions and you know, troubleshooting and not really actually being a chemistry teacher in my opinion, as part of the reason I transitioned back into a face to face scenario.

Bostic, Jessie: Right. OK, so now is [USNU] the only place that you're using nontraditional labs in?

Participant Jessica: Correct, yes it is.

Bostic, Jessie: OK. And do you do you interact with the students any when it comes to the virtual labs?

Participant Jessica: Umm, no other than grading and giving feedback and a every now and then that troubleshooting situation, that's another thing I've not liked about the lab transition. This will be my since January when we transitioned. This will be my third round of students going through these virtual labs, and they're just having so much trouble with the software using the software, learning the software.

Bostic, Jessie: OK.

(outcome of labs for students)

Participant Jessica: Yeah, I'm not a fan. I feel like they're really not getting what they should be out of a lab, but yeah, I am in that troubleshooting situation and I know it's they're still new, and they're trying to refine it some, but the labs don't match up with what we're doing directly in the course necessarily.

Bostic, Jessie: Yeah, well, they are a bit tricky to work with. And I mean just learning to grade them, I'm sorry, but just learning to grade them versus the when they were turning in the lab reports.

Participant Jessica: Mm-hmm, exactly. All I can do is give them feedback. I can't integrate myself in in any way. I can't see what they're doing. I don't know if you are using the same program we're using, but you can't see what they're doing.

Bostic, Jessie: What was it that I interactive or something interactive?

Participant Jessica: Yeah, yeah. And so, like, they'll be in the middle of something and you can't see anything they're doing until they've submit it, so I am like, can you send me a screenshot? I have no idea what's going on right now. I can't pull up your stuff and actually look at it and review it to help you, so I feel like I'm almost locked out of all of the lab stuff. I'm surely there to grade it and give them feedback and that's it.

Bostic, Jessie: Yeah. When they rolled out with these, did you go through the labs any or like test run on with yourself or how did you work out what?

Participant Jessica: Yes. Yeah, I went through them just because you can preview them as a student or whatever, and I went through them just to get an idea of what was going on and looked at the questions associated with them.

Bostic, Jessie: Right.

Participant Jessica: Umm, you know, just to familiarize myself, but at the same time, some of the students are running into issues that I couldn't replicate. So I was like, I don't know what's going

on, so I inevitably end up sending them to the their, you know, the program help people like, sorry, you're going to have to ask them what's going on here because I can't replicate it.

Bostic, Jessie: Yeah.

Participant Jessica: I can't see what you're doing, so again, I feel like I'm it makes me feel horrible because I can't address the issue like I'm just passing them on to somebody else. That's the best that I can do so.

Bostic, Jessie: Right. Was it the same with the lab kits?

Participant Jessica: Umm. Exactly, exactly. They'll be like, oh, I broke this or I only have this mount. You know, we could, we could adjust it in some way, but in trying to replicate something that the computer screen is doing and I'm just like I'm, I'm not getting it.

I don't know what's happening, so yeah.

Bostic, Jessie: Yep.

Participant Jessica: Yeah, I had my I was the I was on the group that went for the first run of them in January. Oh yeah, we had a whole group chat that was going for that first group of people who were doing it. And it was just every week. Like what about this? What about that? No. So yeah, but yeah, like I said, for nonscience major courses. I am 100% OK with the virtual things and seeing how things work, but I really feel like the people who need it as a major course. You know that you know general chemistry, things like that.

Bostic, Jessie: Right.

Participant Jessica: They really need that hands on experience in some way or another so.

Bostic, Jessie: Are you teaching chemistry majors at [USNU] in these chemistry courses?

Participant Jessica: Uh Hmm.

Bostic, Jessie: OK, gotcha. So, you may have already mentioned that and now it's all just blurring together. But you said during COVID you were already teaching online, right?

Participant Jessica: Umm yes.

Bostic, Jessie: OK, so your role didn't change through that at all?

Participant Jessica: Well, I mean, I was teaching online and face to face. So, some of my classes transitioned over and some of them were already online.

Bostic, Jessie: OK. Was there any difference in that transition for you when it was, you know, in a response to the pandemic versus before?

Participant Jessica: Yes. So, one of the classes I had to transition was our instrumental analysis class, which is a junior junior senior level class over chemical instrumentation and it was rough.

Bostic, Jessie: How so?

Participant Jessica: I was very fortunate, like I did the best I could, but I was very fortunate in that a lot of the companies were giving out free software to use for the duration of the year.

Bostic, Jessie: OK.

Participant Jessica: So, my students, we transition a, transition them into using a virtual HPLC and a virtual ramen. And I gave them lots of data sets like OK you you went through the process, you ran this, you got this raw data. Now here's a data set that it produced for you. Now do some calculations with it, so I you know, we were very fortunate that those people were so generous with letting us use their software for free.

Bostic, Jessie: Right.

Participant Jessica: You know, had not that not been the case, I don't know what I would have done because I couldn't justify asking my students to spend $250 for, you know, half a semester of work, you know, to use that software and things like that. So, we were just very fortunate that those people were so willing to let us use their software for free during that time and it was beneficial.

Bostic, Jessie: That's awesome.

Participant Jessica: I think it was good. You know, again, I'd prefer hands on because that's entirely different.

Bostic, Jessie: Well, yeah, yeah.

Participant Jessica: You know that that feeling of injecting that needle and pushing things into the HPLC and listening to the sounds of it and all that fun stuff is not the same as watching it on a computer.

Bostic, Jessie: Do you have any plans to do any of your like use any virtual stuff in your future school courses?

Participant Jessica: Umm, not yet.

Bostic, Jessie: Yeah.

(change in role)

Participant Jessica: I'm, you know, like I think there are fun things that can be done just to give students of experience. I enjoy letting them experience everything, like all the fun, different things. So I haven't integrated any in yet. Umm, depending on the situation, I may or may not do it, but I really just enjoy it like I love blowing things up. That's like, you know, people like, why did you get into chemistry is like cuz I got a blow stuff all the time.

Bostic, Jessie: Yeah, yeah.

Participant Jessica: Awesome. Yeah, like so. And I think my students enjoy that too. I'm constantly setting things on fire and you know, just doing ridiculous things.

Bostic, Jessie: Oh yeah.

Participant Jessica: And I used to show a lot of videos from YouTube and stuff, but I feel like the impact is not quite as much fun as when you do it in person.

Bostic, Jessie: I think especially with this generation where that's what they do all the time and so they can find those videos on their own now, so.

Participant Jessica: Exactly, exactly. It's exactly and that's my students, they come there, Well, that's one of the things I loved about it at high school levels is they would find a video and maybe like, can we do this? And I, you know, I look it over and be like, yeah, let's do it when we

get to this material, we'll do it, you know, like they'll come in and ask me different things and like, yeah, let's do it.

Bostic, Jessie: Yeah.

Participant Jessica: We can totally do this if it fits with the material, then we'll make it happen. So that's fine.

Bostic, Jessie: So, I'm getting the idea that the creativity in that control means a lot to you to be able to tweak it to fit.

Participant Jessica: Yes.

Bostic, Jessie: So, no limit or not have that limitation.

Participant Jessica: Exactly. And that's that's part of with my degree. It's in. You know, it's not an instructional design, but it's in learning and organizational change.

Bostic, Jessie: Alright.

Participant Jessica: So, the biggest thing about the learning aspect that we focused on was I did that students need to feel like they are somehow a part of the work engaged in the work as opposed to it just being a task that they're assigned to do.

Bostic, Jessie: Yeah.

Participant Jessica: And I feel like a lot of these virtual labs eliminate that. It's just a task that you have to do as opposed to like integrating and coming up with something and doing it themselves like my my high school class for my on level chemistry course they had to do for their final they had to do a mini seminar and it was pick a magic trick. Do it explain why it's not magic like disprove this magic trick and then everybody got to pepper them with questions and like.

Bostic, Jessie: Right. Now that's awesome.

Participant Jessica: But they got to pick. They got to pick their own thing. They got, you know, they felt like it was a part of what they were doing as opposed to, oh, it's just the task. A thing that we have to do, so that's kind of one of my biggest things is some of these virtual labs that are using software like that, it kind of takes away that what are we doing you know.

Bostic, Jessie: Yeah.

Participant Jessica: So, I think they could improve it by allowing the students to make do different options. Like what do you want to do? Would you like to do a urinalysis test using this thing or you know like giving them some options so that they feel like in some way they're getting to choose and engage in the equipment a little bit more often. But that's just me.

Bostic, Jessie: Yeah.

Participant Jessica: Exactly. And that's what I tell my students in the chemistry lab. Most of the time, like if they mess up, they're like, do we have to do it all over again? And I'm like no, but your summary should include what went wrong and how you would prevent that in the future.

Bostic, Jessie: Right.

Participant Jessica: Like, that's part of the process. People mess up like it's just part of the process, so I think that's really good.

Bostic, Jessie: Yep. Do you feel like that's probably true for a faculty as well, like with the virtuals we're taken out? We don't get a chance to learn like you're created or, umm, learn from the students doing it. We're just kind of in the background?

Participant Jessica: Yeah, I do. Like I said, I probably if I could troubleshoot better, like if I could actually see where they were going wrong, I might be able to be like ohh this is what went wrong and I would even be able to provide them with better feedback. You know other than well, that's not right. Not really sure where you went wrong there, but it should look something like this. Make sure you did that, you know like.

Bostic, Jessie: Yeah.

Participant Jessica: But yeah, I think it does make it harder for us to learn from what they're going. I already even what they did wrong because when we are trying to provide them with feedback, it's not guided to a specific issue that we can necessarily identify. Sometimes I can, sometimes they can't, so yeah.

Bostic, Jessie: OK, Now the labs that you transitioned for the college, since you designed those and worked with students through those, do you feel like that kept like a gray area in between the you know, face to face? And then this APUS completely virtual. Do you feel like it was kind of a medium ground maybe?

Participant Jessica: Yeah, I do. I mean it is a learning experience. I don't expect everything to like be integrated in and perfect.

Bostic, Jessie: Right.

Participant Jessica: You know, I was talking to some of my faculty at [previous employer] about going through the IDR and like all that fun stuff. And I was like, if you think about it, we're always we're always testing, we're always experimenting on our students. We just not necessarily writing up a report about it like we're always changing and trying to better it in some way, so.

Bostic, Jessie: Yeah.

Participant Jessica: Umm yeah, I think when you, I mean essentially what we've done with these virtual some of these virtual labs is taking them entirely away from the instructors ability to do anything. And in doing that, you have you've made it a black and white situation where like you gotta go there for that. I'm here for this and you know, but when you're working with the students and you can get their true feedback and you can see where they're making mistakes and you can tweak the lab design so that hopefully it's not making that mistake or you can use those mistakes as a learning experience. I think that does that little bit of overlap. That gray area definitely gives you more of that ability to help the students as well as that feeling that you're actually doing something. Umm, in helping them in the like being productive in some way so.

Bostic, Jessie When you transition those before, I'm backtracking a tiny bit, but when you transition those, did you have? Did y'all work with an IDT or team leader? Was it just faculty that worked with OK and that's kind of how it is here too?

Participant Jessica: It was just faculty was just, yeah.

Bostic, Jessie: Is there anything else that you think I need to know or that you want to include?

Participant Jessica: No, I did kind of have something that I wanted to address associated with that. Yeah, I mean. The transitioning I think is a good idea. When we were transitioning all of our material to online. We had to go meet the quality matters. That was the only thing that we were provided with for transitioning our classes.

Bostic, Jessie: OK.

(measuring guidelines)

Participant Jessica: As it had to meet the quality matters rubric, I don't know if you're familiar with that.

Bostic, Jessie: I have read a little, you know Chapter 2 and a dissertation, you read everything about online learning and there weren't many measurements, then came up is that there's not a lot of great measurements, but that was one of them.

Participant Jessica: Mm-hmm. Here. Yes, quality measures has been like from the beginning that has been the rubric to you or quality. Yeah, quality matters, and that's what it is.

Google real quick, it's been a long time since I've actually.

Bostic, Jessie: I think it's associated with Ninninger or someone I read, I remember.

Participant Jessica: Yeah, you can get certificates. Professional development. Yeah, quality matters. It's an entire like. I don't know. It started out that you just bought the rubric, and it was like, here's the rubric.

Bostic, Jessie: OK.

Participant Jessica: And these are the things you should be hitting, but it's transitioned into a whole like learn how to be an awesome online instructor. So, but yeah, that was that was our starting point. That's what we were given to design our courses and then from there we just did it.

Bostic, Jessie: OK.

Participant Jessica: Every school I've worked with has kind of referenced the quality matters at some point in time like this is the expectation.

Bostic, Jessie: OK.

Participant Jessica: Things like that. So that was always kind of our guide for putting together online classes. When I went from [previous employer], which is where I started with those basic labs and went to [second previous employer], they had a an actual department of instructional designers to help us build our classes and put them online.

Bostic, Jessie: OK.

Participant Jessica: And they gave us the quality matters rubric and things like that. And they would help us generate ideas and talk to us about software that they had purchased that was available to integrate in and do different things like that. So that was super helpful. But then again, you know, once you have the class set up, it was hard to go in necessarily and redesign it.

Bostic, Jessie: Mm-hmm.

Participant Jessica: You know every now and then you want to kind of give it a little little freshening up.

Bostic, Jessie: OK. Right.

Participant Jessica: You know, so it was kind of not necessarily easy to go in and redesign the course at that point in time. So we I when I started at [second previous employer], we were using Blackboard and then we transitioned to canvas.

Bostic, Jessie: What platform do you prefer? Just out of curiosity?

Participant Jessica: So I really like to canvas. I was sad when they decided on D2L instead of canvas. I was like, oh, I want I really like canvas.

Bostic, Jessie: We finally found a place we differ.

Participant Jessica: So, well, do you?

Bostic, Jessie: I prefer D2L, yeah, but I think honestly, it's one of those. Like what you're taught on and what you're used to.

Participant Jessica: I really like canvas because it gives you that structure, that integrability and that ability to go in and do a little HTML code editing yourself like my canvas pages didn't look anything like a traditional canvas with like blocks and stuff. Mine was icons and it didn't have the modules link like they just went in through the different little areas.

Bostic, Jessie: OK.

Participant Jessica: So, I had a lot of fun, like designing it and making it look more like a website with a bunch of interactive stuff as opposed to like, here's a list of things to do.

Bostic, Jessie: Right. Alright. Well, thank you. I'll be in touch with instructions for the discussion board and how to access it as soon as possible. Thank you for your time this morning.

Participant Jessica: Yeah, no problem. Have a good one.

Bostic, Jessie: Thank you. Bye.

APPENDIX K

Sample Excerpt From Group Discussion Forum

Hello everyone!

My name is [name], and I am a Biology professor at [university]. I have taught biology since 2018, when I graduated with my master's degree. I started teaching on campus in 2018 at a small liberal arts college. I started as an adjunct, but now I am full-time. I mainly taught general biology courses and some upper-level courses. They didn't have any online Biology courses then, so I was just teaching face-to-face and your traditional labs. Most of their labs are seek-and-find labs where the students have a packet of information they have to use the materials in the lab to answer questions. When the pandemic hit, they moved courses online in the spring of 2020 and stayed online through the fall of 2020. It was rushed and hectic, but it worked out because we made virtual seek and find labs. I taught with them online through those two semesters and then went back in person that next spring, 2021.

During that time, there were many positions available online, and I enjoyed the flexibility in the schedule. I also wanted to see what else was out there in terms of science online, more than the boring seek-and-find labs I had done. I applied for several online positions and started teaching online as an adjunct with USNU in a position that taught general biology online with virtual laboratories. They used lab kits when I started, and they were pretty cool. The students would set up in their homes and conduct the labs. I felt like this still kept them hands-on but allowed them to have families and careers. They ended up switching to virtual labs, which cover the same things but have no hands-on access. I don't think the experience is the same, but they are more budget-friendly.

The transition during the pandemic is a blur, but when I started teaching online with USNU I went through a month-long training and then shadowed a course for a term. So, I felt very prepared when it came to teaching online with them. When I started in my next position, I wasn't offered much training, but I knew a lot already, so I was able to get started pretty quickly.

I have since left the small liberal arts school and teach at a larger four-year university that offers a significant amount of online coursework. I now teach both in-person and online courses with my full-time position and online with USNU.

I am looking forward to hearing about everyone's experiences! [name]

Hello! Thank you for your informative post! JB

APPENDIX L

Code from NTL Examples

1. Type of NTL: Online, Remote, Lab Kits

2. Description/Writing Time Included

3. Discipline/Subject

4. Delivery

APPENDIX M

Modified Code from NTL, Interviews, and Group Discussion Forum

1. Team Effort/Support
2. Demographic/Experience
3. Transitioning Positions
4. Student coursework experience
5. Lab Preparation
6. Critical Guidelines
7. Format of labs
8. Change in Roles
9. Effectiveness of NTLs

APPENDIX N

Participant Interview Reminder/Confirmation Email

Dear [name],

I am writing today with a friendly reminder that you are scheduled for an interview with me at [date/time]. The link for the Microsoft Teams meeting is included in this email. Thank you again for agreeing to be part of the study.

<link>

For informational recollection, just a reminder that as a doctoral candidate in the School of Education at Liberty University, I am conducting research examining the transition that science faculty experience when they begin teaching non-traditional laboratories as part of the requirements for a doctoral degree. My study aims to provide insight into this transition, examining the experiences with change that may occur.

If you have not already, please reply with the following:

1. Signed consent form (attached)
2. An example of a non-traditional lab you have used in the past.

It should take approximately 1 hour for the interview and 30 minutes for the focus group forum. Names and other identifying information will be requested for this study, but participant identities will not be disclosed. You have the right to withdraw from the study at any time, and your previous contribution up until that point will be destroyed.

A consent document is attached to this email. The consent document contains additional information about my research. You must sign the consent document and return it to me when you submit the lab example and before the interview can be conducted.

Sincerely,

Jessie Bostic
Ph. D. Candidate
[redacted]

APPENDIX O

Sample Researcher Reflective Journal Entry

Reflection Journal

August 28, 2023

I have interviewed and transcribed about 2/3 of the required participants and am struggling to locate more participants. My parameters are tight in hindsight, so perhaps that is not helping with qualifications. Also, a few have surveyed to participate but have not responded to my emails to schedule their interview. It is the start of the fall semester, so perhaps they are busy with work. Of the ones I have done, I am surprised at how many see the importance of online options in science but don't enjoy teaching them. I didn't expect this because I assumed that if they are using NTLs, they must like teaching them, but it seems to be more of a "job" than a passion for most. Here, the trade-off for extra income from home or own your own time is a trade-off for the enjoyment of the position. I had one tell me outright they hate online labs but know that students limited by time and commitments need science options online – no sugar coating there. Another mentioned their role changing from a teacher to a problem solver, and I can identify with this feeling.

When students are provided with all the materials to learn independently, they only reach out to you when there is a problem. So far, participants have shared various transitional experiences that were initiated for different reasons, which is another thing that surprised me but shouldn't have because it was represented in the literature review. If a person is involved in the decision to make a change, they are more likely to be content with it, but if they were forced to, they are less likely. Most participants started using NTLs out of convenience, for the most part, being able to teach from a distance or teach additional courses online for extra income.

APPENDIX P

Participant Member Check Example

Leadership	When you first started learning to teach online with them and everything, what was that experience like? It was good. I think part of it depends on who's running the department or division.
Training	Was it like a two-week training or longer? I don't know if it was a whole term, but there was a training and then you would also shadow people and so that would be a whole quarter.
Virtual Models	Uh virtual model that that goes over each of the systems, it seems, yeah, seems to be OK because, yeah, with anatomy, although you know, thinking on it, they're not really doing a whole lot of the Physiology, at least so far from what I've seen, it's been all, all the anatomy. So, show a structure name, a structure, not a whole lot about what that structure is doing.
Brick and Mortar uses computer models too	That's struggling, but but it's odd with life in that, you know, we say brick and mortar, but they've also gone more computer and models and using actual or bodies or chemicals.
Not a huge transition	That I've had that I've gone back and forth with her that discussions, discussion forums. But but no, I you know, I I didn't think of that huge of the transition.
Transition from Home Lab Kits vs Virtual	Yeah, pretty smooth. Actually I think I like it better. Because, you know, people aren't messing with with the chemicals and and they're not asking you where they get this and where they get that.
Easier when you don't have to set up lab	I think what makes it easier is not having to set up lab. Not having to again mess with chemicals or getting dyes all over you over you.
Virtual labs are good substitutes.	So, I think that part of it's great and and and really there's been so much research behind a lot of these lab exercises that even the simulated versions of them just seem to work out fine. But you know the argument was always you get a lot more information when you have the actual thing there that you can play with. But I came to the point along my journey to say, well, you need to know that as an anatomist, you need to know that it's a surgeon. Chiropractors aren't going to cut open the body, so do they really need to get their hands and in there? They need the basic information in the theory. They need to be able to say that's a stomach.
Experience is different, concepts are the same	I think it has to go more with thinking about what the end goal is. I mean, even in chemistry they like watching you poor two things together and blow something up. You know, and so that gets them engaged.

	But they can still get that same information by doing a a virtual lab or yeah.
Faculty engagement is harder online	I think as far as faculty goes, it's a little harder to engage. In regards to discussion boards It is difficult to when they are answering, you know, the same questions and stuff and all from the same article.

APPENDIX Q

Participant Invitational Email for Group Discussion Forum

Dear [name],

I appreciate your willingness to participate in my dissertational research. Thank you for allowing me to interview you about your transition from using traditional labs to non-traditional labs; your input will be a vital part of my study.

I am writing to invite you to participate in the last part of the study, the group discussion forum. CreateAForum will host the discussion board; the link is included in this email. You must register for the site; it will ask for your name, email, and phone number to create a username and password. Once signed in, you can view the prompts and post to the discussion board. The prompts are:

1. Please summarize your general experiences with traditional and non-traditional laboratories for the group.
2. Please provide a brief timeline of your experiences transitioning from traditional laboratories to non-traditional laboratories.
3. How do you use non-traditional laboratories currently?

Please use this link <link> to access the forum. The forum will open on [date/time] for ten days.

Thank you again for your time,

Jessie Bostic